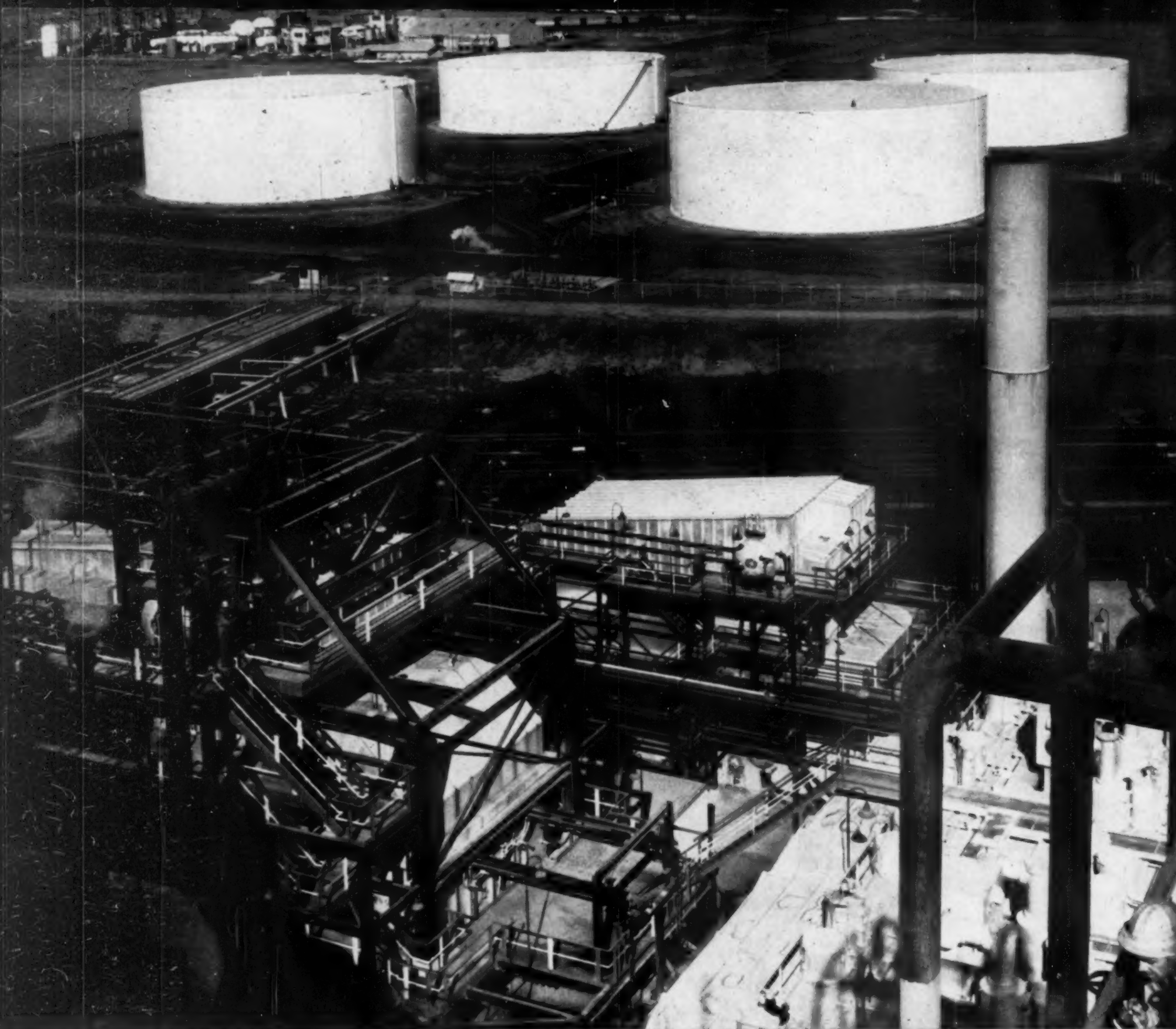
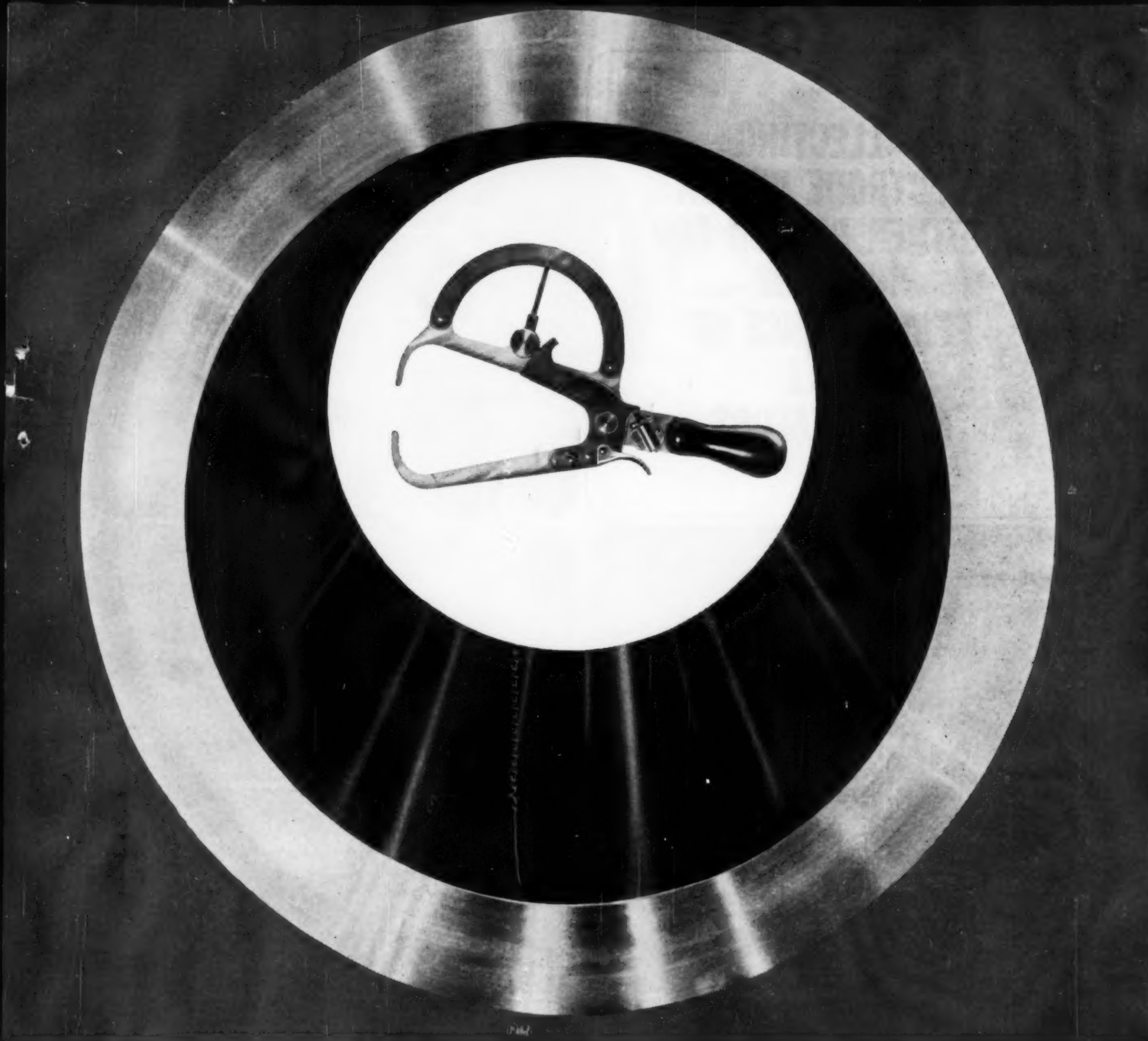
MECHANICAL ENGINEERING

July 1961

ANNUAL REVIEW

Communications Satellite





MECHANICAL ENGINEERING

PUBLISHED BY
THE AMERICAN SOCIETY OF
MECHANICAL ENGINEERS

Contents

VOLUME 83 • NUMBER 7 • JULY, 1961

THE COVER

Thousands of pieces of man-made sapphire will cover the surface of the communications satellites now being developed by Bell Telephone Laboratories. The goal: Satellites that will work dependably for many years, serving as radio relay stations for communications overseas (see MECHANICAL ENGINEERING, June, 1961, p. 78). The solar cells are small silicon wafers mounted on the outside surface to convert sunlight into electricity. Sapphire sheathing will protect the solar cells from deteriorating effects of electron bombardment; it will convey heat away, preventing cells from overheating in long periods of continuous sunlight. Being hard, it will resist erosion by micrometeorites. The "working" telephone satellite should last 10 years. See Photo Briefs, p. 64.

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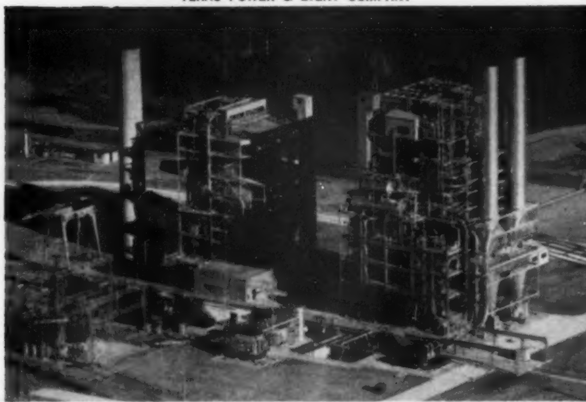

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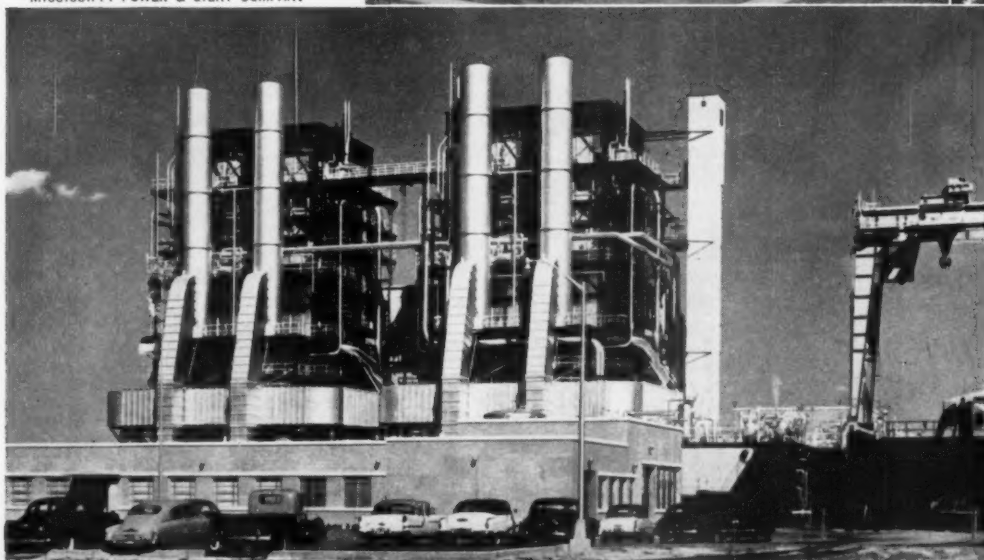

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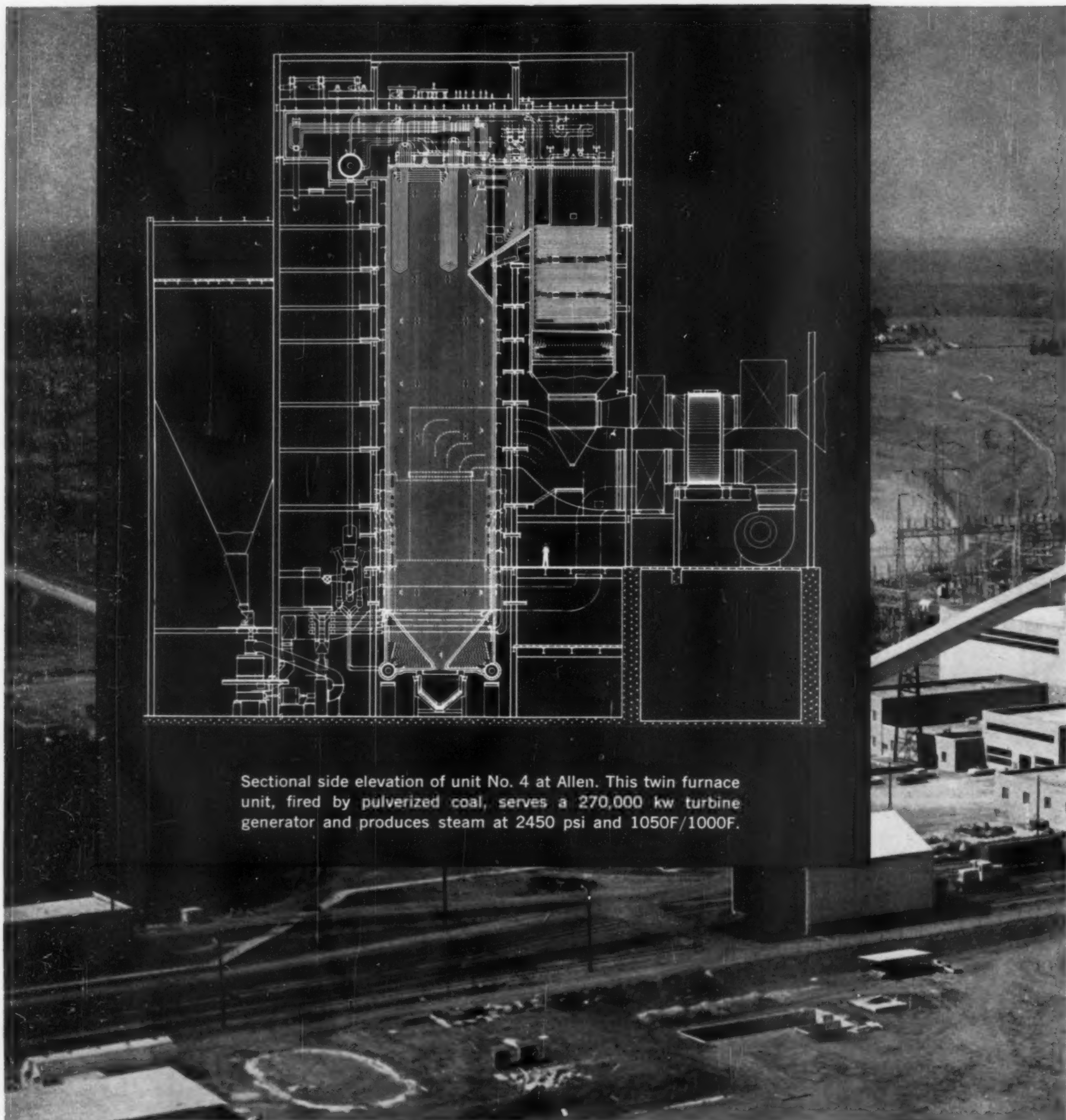

Sectional side elevation of unit No. 4 at Allen. This twin furnace unit, fired by pulverized coal, serves a 270,000 kw turbine generator and produces steam at 2450 psi and 1050F/1000F.

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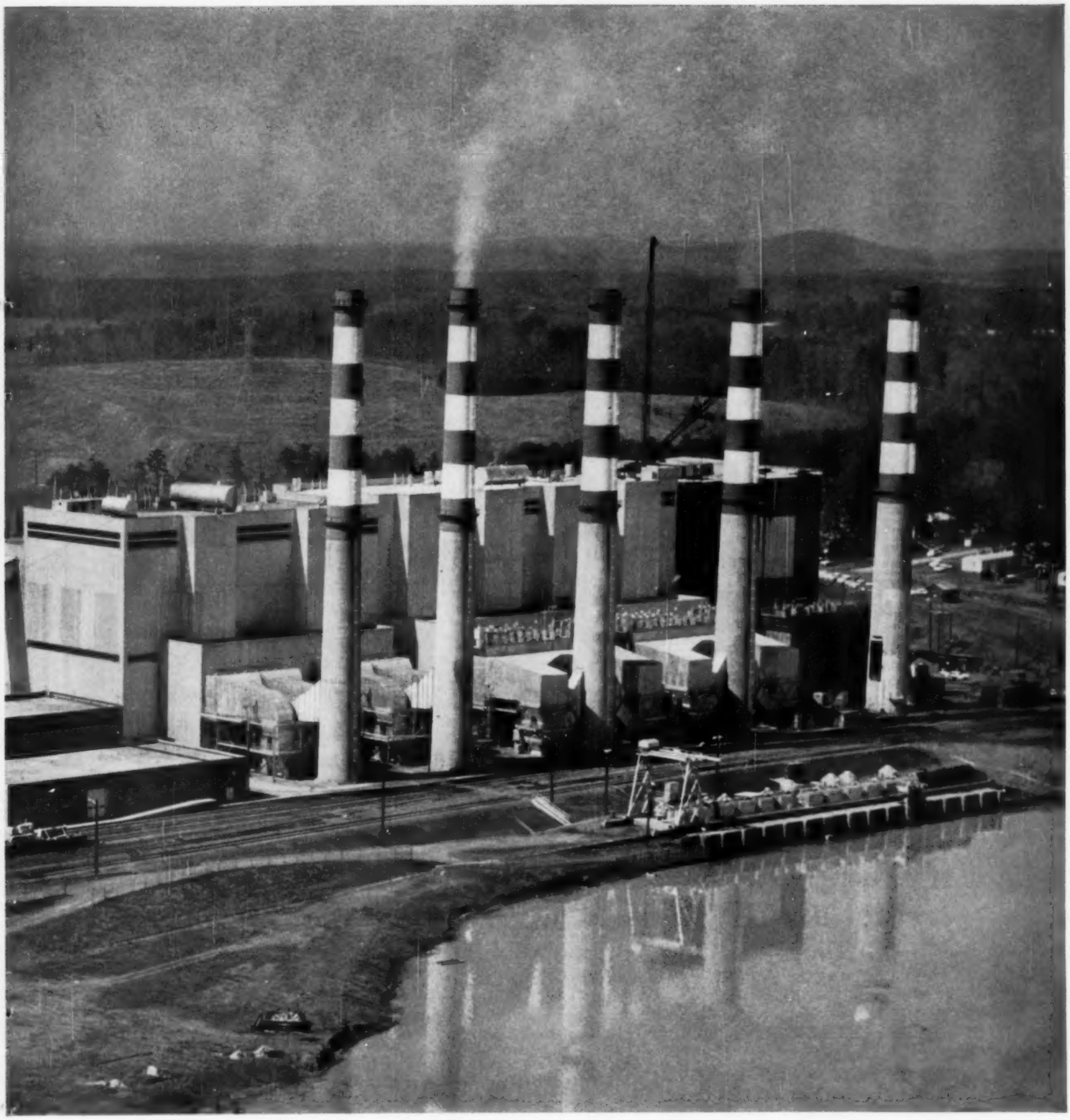

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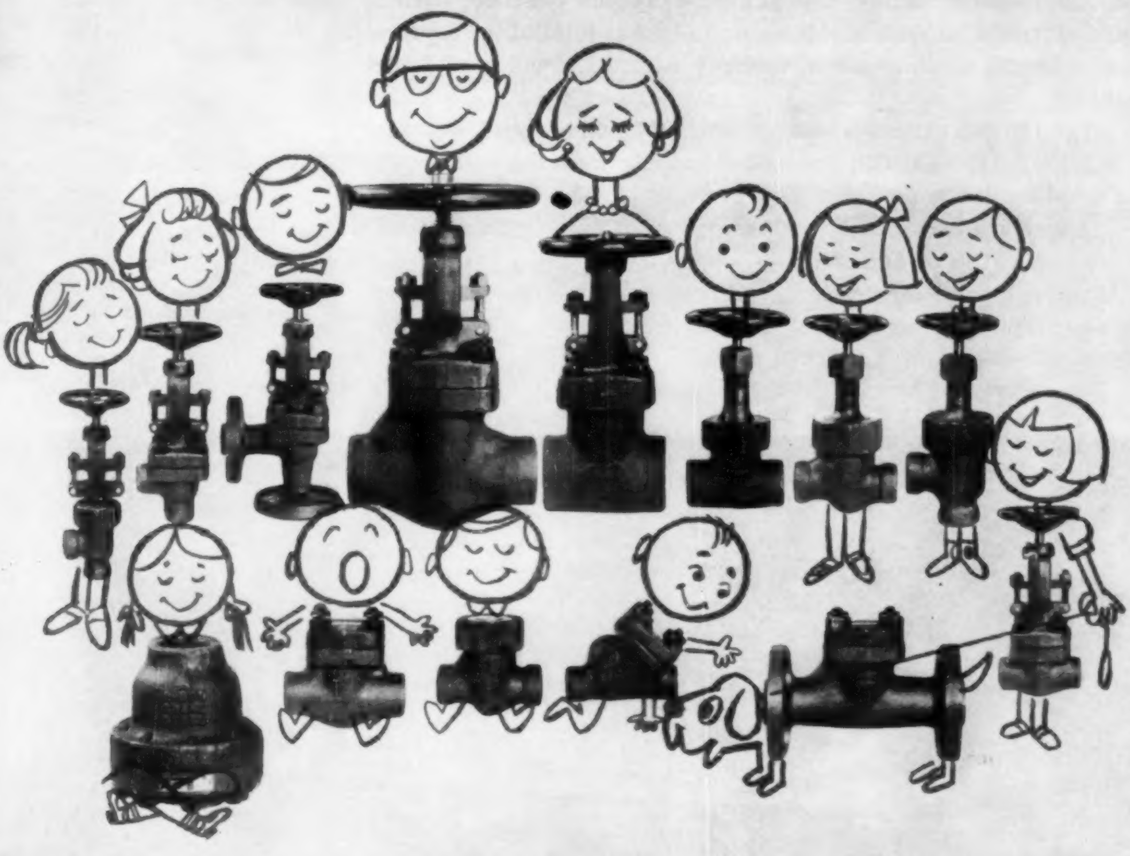

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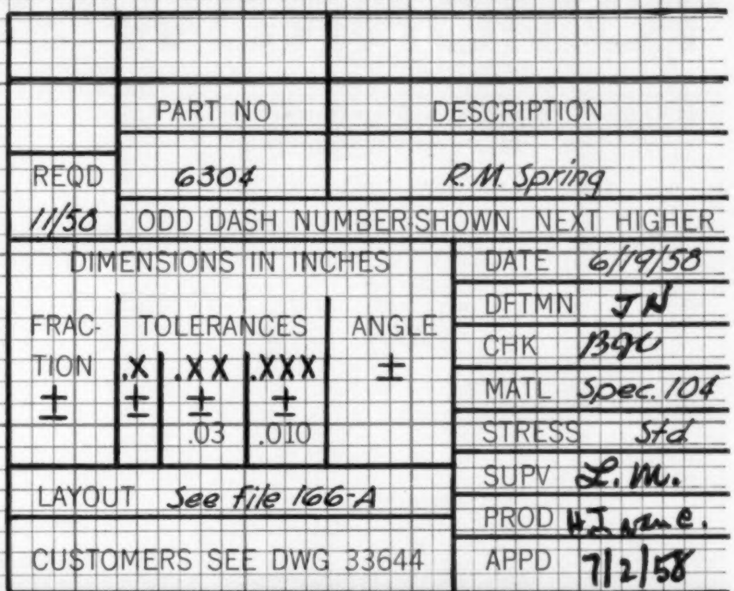

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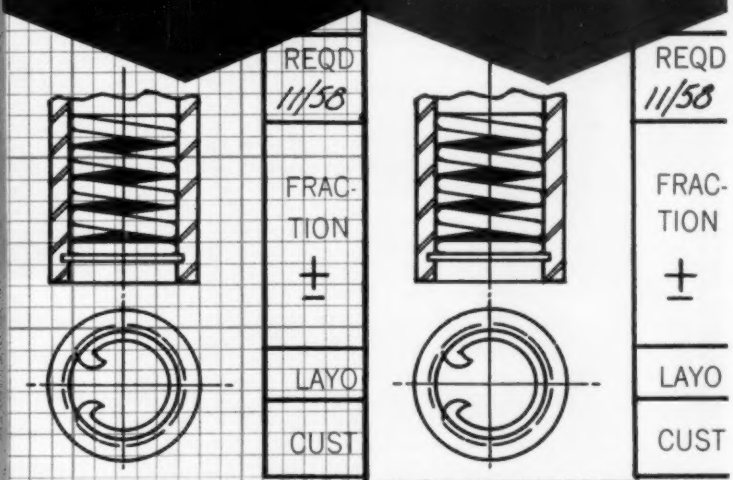

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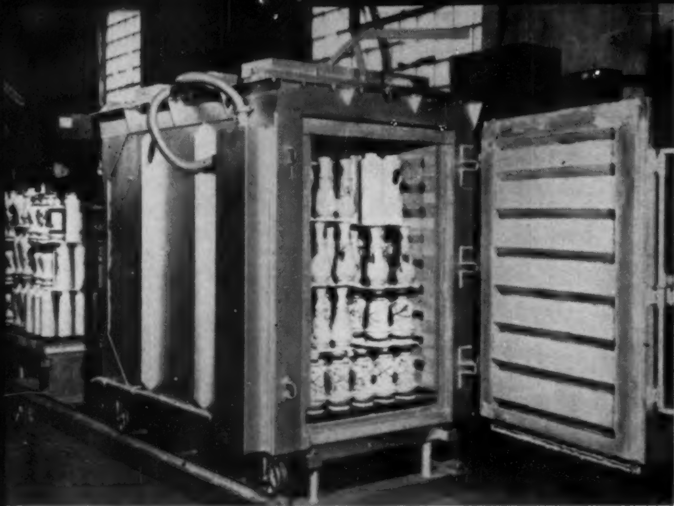

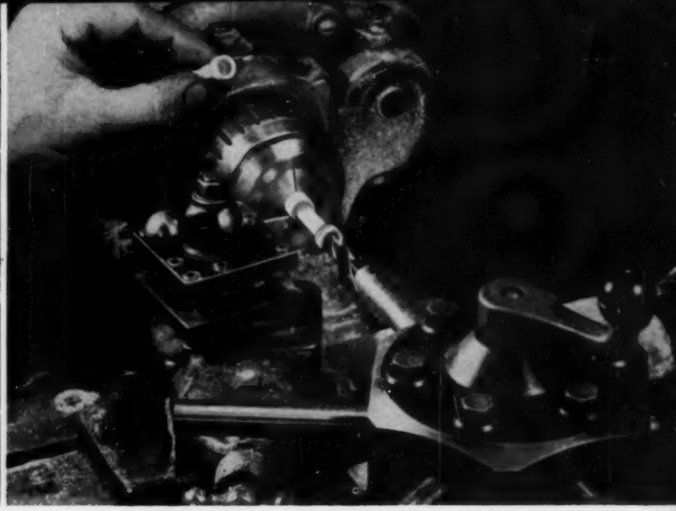

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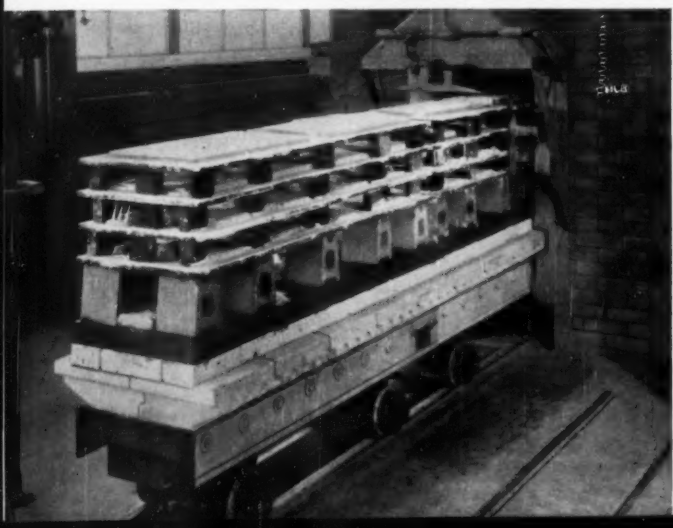

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MECHANICAL ENGINEERING

VOLUME 83 • NUMBER 7 • JULY 1961

John Moyes Lessells

1888-1961

The stocky, sandy-haired, blue-eyed Scotsman whose speech rang with strong traces of a native burr, was always a familiar figure at ASME Meetings or at Headquarters. John Moyes Lessells died, on May 17, 1961, and with his passing the Society has lost one of its most prominent members.

Affectionately called Professor Lessells, he was one of the small group who founded the ASME Applied Mechanics Division in 1927 and one of its chief supporters. To his credit, in particular, is the high standing of the *Journal of Applied Mechanics* which he served as Technical Editor from the time it was instituted, in 1935, until 1956.

It is recalled that when Transactions became a monthly periodical an attempt was made to devote each February issue to papers of the Applied Mechanics Division—until 1935, when the *Journal of Applied Mechanics* was authorized by the Publications Committee at the request of that Division. Decision to set up the *Journal* as a separate Transactions quarterly was based on a demand for an international journal in the field of applied mechanics which none of the societies involved, except ASME, offered to undertake.

Perhaps the most important element in the success of the *Journal* from the point of view of the Publications Committee was the appointment, on recommendation of the Division, of John Lessells as Technical Editor. As one of the organizers of the Division and an enthusiastic proponent of the *Journal*, he devoted his time and talents (without remuneration) to the task of centralizing authority and responsibility in his office. Result: The Editorial Department was relieved of all duties except those of styling manuscripts and producing the finished publication.

From the start, the relationships of Professor Lessells with the ASME Editorial Department were always on a basis of friendly cordiality. Whenever difficulties arose between the Department and authors, a call to him would insure prompt and effective treatment.

Through his efforts the *Journal of Applied Mechanics* grew from an experimental venture to a respected engineering quarterly with the highest international reputation.

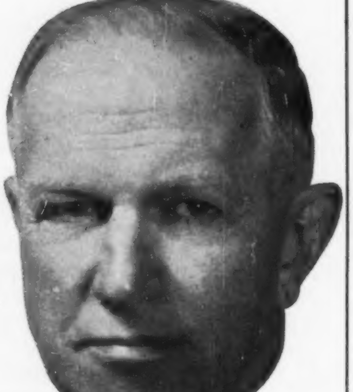
In 1956 Professor Lessells asked to be relieved of the editorship of the *Journal*. He was named Honorary Editor in 1957, and his interest in the *Journal* and his advice and long experience were always available.

Born in Dunfermline, Scotland, in 1888, Professor Lessells was educated in that country, receiving a BS degree in engineering from the University of Glasgow in 1915.

During World War I he served at Rolls-Royce, Ltd., in Derby, and at the Whitworth Company, Ltd., Newcastle-on-Tyne, where his work dealt mostly with inspection of aero-engine parts. In 1918 he became special engineer to the works manager of Rolls-Royce, Ltd., and was engaged in design and production.

Lessells came to the United States in 1920 to join the Westinghouse Electric and Manufacturing Company where he organized the Mechanics Division of the Research Laboratories. The early 1920's proved to be a turning point in Westinghouse history because, until then, little analytical and research work

Editor, J. J. JAKLITSCH, JR.



John Moyes Lessells

Engineer..

Educator..

Editor....

had been done on the mechanical problems encountered in electric machinery. Other companies encountered similar problems, but it seems that in this respect Westinghouse led in the development of mechanical research and in the training of young men for this purpose. The origins of this development went back to the time of B. G. Lamme who, nearly a decade earlier, had organized an electrical design school in which a small number of gifted college graduates received special training in preparation for a career with the company. Under the leadership of G. M. Eaton, a similar development took place in the early 1920's on the mechanical-engineering side. Lessells played a significant role in this development—in the organization of research work in materials testing, vibrations, and so on. His division became a focal point for a great many men of outstanding ability, among whom were such ASME Members as Timoshenko, Den Hartog, and Nadai.

From 1931 to 1934 he was Manager of Engineering of the Steam Turbine and Diesel Engine Works of Westinghouse at South Philadelphia. Here, too, he was successful in attracting such men as Ormondroyd, Soderberg, Karelitz, Kroon, and others. During these years a completely new spirit was introduced at the South Philadelphia plant. New methods of design and research were initiated, and the present position of the Westinghouse Corporation in the turbine field stems largely from his era. Without it, the company could not have entered the aircraft field with the success that it did. Many of the leaders engaged in that work today are the men who were employed during Lessells' period as manager.

Lessells engaged in consulting practice of his own in 1935, and in 1936 became an Associate Professor of Mechanical Engineering at the Massachusetts Institute of Technology. In 1946 he organized Lessells and Associates, Inc., a company of consulting engineers in Boston, Mass.

He joined ASME in 1923 and was made a Fellow in 1952. He became an Honorary Member, ASME, in 1952, "for outstanding contributions to the development of Applied Mechanics within The American Society of Mechanical Engineers . . . and for his initiative and vision during the early days of the Division of Applied Mechanics, for his steadfastness of purpose in supportining it throughout the years, and for his long years of service in maintaining the high standards of the *Journal of Applied Mechanics*."

John Lessells served ASME in many capacities. Besides being one of the founders of the Applied Mechanics Division, he served as its Chairman. He also served on the Professional Divisions Committee for four years and one year as Chairman.

Among the societies in which he held membership are The Institution of Mechanical Engineers, from which he received the Bernard Hall Prize, and The Franklin Institute, which gave him the Levy Medal. Professor Lessells, was the author of a widely recognized text, "Strength and Resistance of Metals," and, with S. Timoshenko, he authored a book, "Applied Elasticity." He also had many papers published.

John Lessells possessed a solid stability that inspired confidence. He had strong convictions with regard to a more rational approach to design problems and the power of applied mechanics in achieving this goal. He was particularly effective in catalyzing potential talent toward effective results in this direction.

His associates will remember him as a vigorous and a widely read man, eager to discuss a broad range of subjects, especially national and international problems. He was endowed with a friendliness that had the warmth of affection. An explosive, infectious chuckle punctuated his lighter conversation. He looked forward to the Annual Meetings of the Society and did not miss one during his entire professional career. To many of his friends from coast to coast, the Annual Meeting will not be quite the same—missing will be the stimulating conversation, the humor, the strong Scottish accent, the enthusiasm, and the sound advice of John Lessells.

A LOOK BACK

MANAGEMENT

The "look back" is to the decade 1910-20, when the modern themes of management came into prominence. Ahead are questions: How shall managers be trained? What are the limits of manageability? By what code shall management live?

A LOOK AHEAD

By Peter F. Drucker[1]

New York University, New York, N. Y.

MANAGEMENT, as a specific discipline, as a specific kind of work, as a specific function in society and economy, was developed, almost entirely, within the past fifty years.

Taylor's "Principles and Methods of Scientific Management" appeared in 1911. Together with his famous testimony before the Congressional Committee a year later, this converted what had been a technique into an organized, systematic, teachable approach to the study of work and of its rational organization. Almost at the same time Elihu Root, reorganizing the United States Army, and Henri Fayol, reorganizing a French mining company, established the counterpart to Taylor's study of the individual task within a work force. They established the systematic study of organization to determine what tasks have to be performed. And at roughly the same time the Germans, especially Schmalenbach, developed *Betriebswissenschaft* (a term, incidentally, as impossible to translate out of the German as "scientific management" is impossible to translate out of the American); namely, the systematic study of the individual transactions which together make up the total economic results of an enterprise.

These three approaches look at enterprise and its management in isolation. But in the years after 1910, we also developed, for the first time, approaches that looked upon enterprise and management in society and economy. In 1911—at the same time at which Taylor's "Principles and Methods of Scientific Management" appeared—Schumpeter in Austria published his "Theory of Economic Development" which, for the first time, raised the question of the role of the manager in a modern expanding economy. Such recent "discoveries" as innovation, marketing, or long-range planning were all anticipated in this book. In the years before World War I, Walther Rathenau in Germany first concerned himself with the impact of large organization on modern society and with the responsibility of management in a modern society. His concern was echoed in the United States, in the closing years of World War I, by Henry Gantt.

The question of the individual in the plant community and the industrial organization was the first of the management themes struck—it was Robert Owen's main concern. It was, however, the last one to be tackled by modern management thinking. It was not raised again until World War I, most effectively perhaps by Elton Mayo, then still in Australia.

Management Taken for Granted

Today we find ourselves confronted with the amazing fact that we have always taken top management for granted, to the point where we know nothing about it.

In the traditional approaches which focus on the function of enterprise in economy and society—the Rathenau line of concern with social responsibility or the Schumpeter line of concern with managerial and entrepreneurial

[1] Professor, Chairman Management Area; Management consultant and writer.

Contributed by the Management Division and presented at the Winter Annual Meeting, New York, N. Y., Nov. 27–Dec. 2, 1960, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from Paper No. 60—WA-46—"A Look Back and a Look Forward."

MANAGEMENT

FIFTY YEARS OF PROGRESS IN MANAGEMENT

This paper is part of the report, **"Ten Years' Progress in Management, 1950-1960."** All parts of the current report also are being published, along with previous Ten-Year Management Progress Reports, in the book, **"FIFTY YEARS' PROGRESS IN MANAGEMENT."** (See "Reviews of Books," MECHANICAL ENGINEERING, February 1961, pp. 104-105).

Price of the book: **$10.50** ($8.40 to members of ASME).

Walker L. Cisler, Fellow and Past President of ASME, says in a foreword to the book: "The industrial successes and failures of the past fifty years bear pertinent witness to the fact that industrial existence does, in essence, depend upon progress in the use of the skill of management ... The current ten-year report, the fifth of a series, portrays the latest decade of managerial advancement."

economics—top management is the only thing that is seen. The enterprise itself is seen practically as an extension of top management. We know today that things are not so simple. The organization, even in a small business, is a good deal more than the extension of top management. We know, for instance, that the basic problem in the decision-making function of top management is not to make the decision itself. It is not even to get the "facts" about the decision. The basic problem is how to make a decision effective.

We are becoming aware of the problem of manageability.

There are, in all likelihood, limits beyond which an enterprise becomes too big to be managed, and particularly too complex to be managed. These limits may well be capable of being pushed outward by such new developments as organized information and decisions systems in the business, systematic business research, and systematic organization of self-governing businesses within the large enterprise. But there is, in all likelihood, a limit even to this.

Business enterprise is only one of the large power centers which have grown up in modern society. It is, incidentally, not even the one that has grown the most or the biggest. Modern government in these past fifty years has grown at least as fast. The labor union has become a major center of power. So have the armed services in this age of the "absolute" weapons, or the government bureaucracy. But business is distinct in that there are both large and small units existing, working, and competing side by side.

This is obviously a unique strength—perhaps as important for the maintenance of a free society as the realization that society need not explode in the inevitable class war between the very many destitute and the very few rich. But it also presupposes some understanding of what kind of activity is best performed within a large business, and what had better be left to the small one. This, too, is a problem of manageability. On this, too, we so far can only ask a question, and cannot, so far, even define it properly, let alone answer it.

Another major area is that of decision-making. During the past ten years this has become a central focus of research and thought. For the first time we believe that decision-making can be made rational to some extent. At the very least, we can define the nonrational elements within it. But so far we have not succeeded in doing much beyond writing manifestoes.

What Is a "Decision"?

One problem that is still ahead of us—one that cannot be tackled within any one of the traditional approaches to management—is that of distinguishing between "decision" and "decision." We do not speak of a "decision" that two and two make four; we call it the "right answer." In a good deal of modern decision theory, especially as applied to managerial decisions, we talk of "decisions" when there is actually only one right answer. This applies to all problems where the job is to restore or to maintain the operation at a preset level. These are the routine decisions—these we understand. But we understand them precisely because they are not decisions.

Then we have a whole group of decisions which we would call managerial in that they deal with the allocation of existing resources, especially of people. Here there is no right answer. Here, in other words, there is already risk. But here there is still a range of optimal solutions, each with a definable risk or balance of risks. Here, obviously, belong all the "inventory decisions" of which we now hear so much—and again these are not really decisions. These also are not, usually, the decisions which make a difference between survival and death of an enterprise.

But as to those last ones, the entrepreneurial decisions, we know very little. Here there is obviously no one right answer. There is not even a range of optima. There is only the ability to take the right risk—the ability, in other words, to innovate and change the trend rather than follow it or anticipate it. This, too, requires strict and rigorous mental discipline. But it is a very different kind of decision, requiring very different kind of "facts," and having very different impact from either routine or managerial decisions. Above all in this, the only truly critical decision, the aim is not to eliminate risk, indeed not even to minimize it, but to make the enterprise capable of taking bigger risks—but the right ones.

The New Worker

A unified approach is needed for the new great tasks in respect to the social and political problems of enterprise and management.

We still tend to think of two classes in industrial society; i.e., "manager" and "workers." Harold Smiddy points out the danger in this. It is not only dangerous, however; it is rapidly becoming completely fallacious.

The 20 papers of the recent report, listed below, were presented at ASME's 1960 Winter Annual Meeting, and will appear in a forthcoming issue of the **Journal of Engineering for Industry—Trans. ASME.**

Management's Past—A Guide to Its Future by L. M. Gilbreth & W. L. Jaffee . . . **The Philosophy of Management** by L. Urwick & A. M. Lederer . . . **Management as a Profession** by H. F. Smiddy . . . **Practices in General Management** NEW DIRECTIONS FOR ORGANIZATIONAL PRACTICE by B. J. Muller-Thyn FINANCIAL by R. B. Curry MEASUREMENTS AND CONTROL by A. W. Rathe . . . **Practices in Operational Management** THE MANAGEMENT OF INDUSTRIAL RESEARCH by H. K. Work ENGINEERING MANAGEMENT by C. E. Paules MANUFACTURING MANAGEMENT by H. B. Maynard PERSONNEL MANAGEMENT by C. E. French DISTRIBUTION MANAGEMENT by J. R. Hawkinson THE FEDERAL GOVERNMENT by H. K. Hyde LOCAL GOVERNMENT AND OTHER NONPROFIT ORGANIZATIONS by G. M. Goettelman . . . **Management Science** by E. H. Weinmurm . . . **Management Education** COLLEGES AND UNIVERSITIES by E. P. Brooks PROFESSIONAL SOCIETIES by C. E. Davies INDUSTRIAL by F. F. Bradshaw . . . **International Progress in Management** by E. Mittelsten-Scheid . . . **A Look Back and a Look Forward** by P. F. Drucker

The majorities of a modern industrial society are essentially the professional people who work as nonmanagers, but also as nonlaborers, who are middle class though employed, and who see themselves as "part of management" without being "managers," and as "workers" without, in the slightest degree, considering themselves "proletarians," let alone exploited.

This is the social reality of the twentieth century—and its social problem. Economically these people are not a problem. In that sense we can say that we have overcome the nineteenth century "social question." We know, at least, that it cannot be solved through any of the nineteenth-century prescriptions. But it can be solved through the unique twentieth-century prescription of economic development based upon high investment in knowledge and in the people who bring knowledge to work.

For the manual worker productivity consisted in increasing output per hour or per dollar spent by organizing his task and his motion. For the "knowledge worker" the question is less how much he produces than whether he directs his attentions to the right "product." It is effectiveness rather than productivity that characterizes his economic contribution. And productivity itself in the knowledge worker is much less a matter of the individual doing more, as it is a matter of the group doing better. These are new things. So far none of us, whether we be Americans or Russians or Europeans or Japanese, knows how to do this.

There is the great political question of the legitimacy of management. On what ground does management base its authority? This management is not and need not be based on exploitation and force—that, in other words, the Marxist interpretation of history is not "scientific," let alone "inevitable"—even the Marxists today probably know. But it is not enough for a leading group not to be exploiter and usurper. It needs a ground for its power. It needs a code of responsibility and a focus of accountability.

Here is a central task awaiting the student of management—a task, essentially of political theory, but one that cannot be tackled without a great deal of knowledge and understanding of management, its concerns, its functioning, and its economics, organization, and philosophy.

The Exploding Management Universe

Management as a supernational function and discipline also goes back a good long time. It is forty years now since, as a result of World War I, two men founded the International Management Movement: Herbert Hoover, the mining engineer turned statesman, and Thomas Masaryk, the philosopher-historian turned statesman.

But essentially, up until very recently, management was seen as a phenomenon of the "developed" countries. And, by and large, despite the exception of Japan, this was seen as being confined to the "western" world; that is, essentially to countries peopled by nations of European stock.

Today, as no one needs to be reminded, this is simply no longer so. This is the greatest event, perhaps, in the short history of management. It is also the event that makes the greatest demand on our knowledge of management and on the dedication of managers.

Above all, it demands—and soon—a unified approach to management as a discipline, and to managing as a kind of work. We face today, all over the world, a demand for people capable of doing the work of a manager—in tremendous numbers and possessing ability, knowledge, and integrity of a high order.

We have been teaching "management" for fifty years. Indeed, management education, too, is half a century old—the Harvard Business School, the first one to be called "School of Business Administration," just celebrated its fiftieth birthday. But can we teach management? Can it be learned?

A Discipline of Management

The one thing one can teach and learn, we lack so far: A unified discipline of management; a concept of the work of managing as technical, social, economic, and moral; and, above all, an ideal type of the professional manager who has technical knowledge and moral excellence, who can do and who can think, who can bring together people in common effort to produce goods but also to produce a good society of free men.

The world-wide cry for economic development is in large measure the result of the management achievement. But this achievement also transformed management and, above all, the tasks it has to fulfill. What is needed now cannot be satisfied by technical excellence alone, but also not alone by moral responsibility or human relations. From now on "management science" and "scientific management," "managerial economics," and "human relations" will have to be made one in the theory as well as in the practice of management.

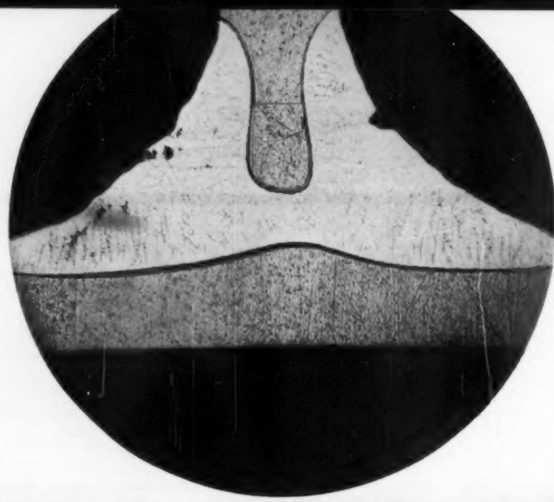


Fig. 1 Photomicrograph of a 90-platinum 10-rhodium brazed joint showing the excessive erosion of the Fansteel No. 82 parent metal

BRAZING REFRACTORY

By Mel. M. Schwartz
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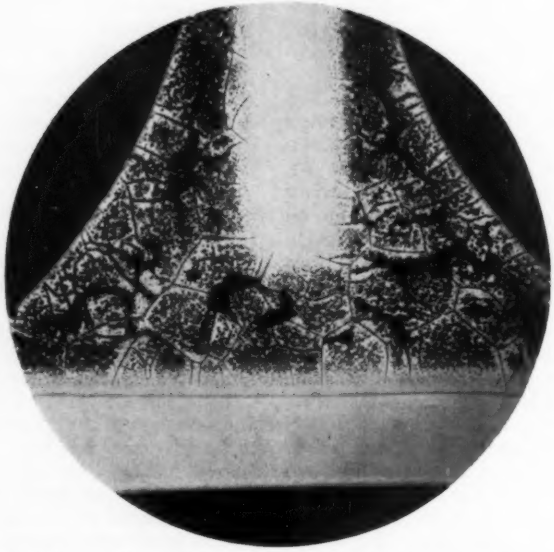

Fig. 2 A pure-titanium brazed joint. The parent metal, Fansteel No. 82, shows no signs of erosion, but good "wetting action" is apparent.

They settled on columbium alloys for a sandwich-type structure capable of standing up at 3000 F—using platinum and titanium braze alloys. Results: Promising.

Table 1 The high-temperature brazing materials evaluated

Material	Palladium	Palladium (Pt)	Titanium (Ti)	90 Pt-10 Ir	90 Pt-10 Rh
Brazing temp, deg F	2900	3300	3300	3300	3450

Table 2 Materials which withstand the desired brazing temperatures but cannot be used for tooling since they cause contamination of refractory metals

Material	Moly	Tungsten	Tantalum	Columbium
	Strong carbide formation			
Graphite	Beyond 1200C	Beyond 1400C	Beyond 1000C	Beyond 1000C
Al_2O_3	Up to 1900C	Up to 1900C	Up to 1900C	Up to 1900C
BeO	Up to 1900C	Up to 2000C[a]	Up to 1600C	Up to 1600C
MgO	Up to 1800C	Up to 2000C[a,b]	Up to 1800C	Up to 1800C
ZrO_2	Up to 1900C[a,c]	Up to 1600C[a]	Up to 1600C	Up to 1600C

Material	Moly	Tungsten	Tantalum	Columbium
	Strong carbide formation			
ThO_2	Up to 1900C[a]	Up to 2200C[a]	Up to 1900C	Up to 1900C
Sillimanite	Up to about 1700C	Up to about 1700C	Up to about 1600C	Up to about 1600C
Firebrick	Up to about 1200C	Up to about 1200C	Up to about 1200C	Up to about 1200C
Magnesite brick	Up to about 1600C	Up to about 1600C	Up to about 1500C	Up to about 1500C

[a] In vacuum of 10^{-4} mm, under protective gas about 100 to 200C lower temperatures.
[b] Strong magnesia evaporation. [c] Strong molybdenum evaporation.

THE refractory metals are just emerging as important practical materials for high-temperature applications. However, practically every order involves a heavy measure of development as well as straightforward production. Above, say, 2500 F, there are no proper criteria for design specifications. There aren't even adequate testing procedures and facilities for developing such criteria. As often as not, a new operational requirement will necessitate a whole new look at both materials and fabrication techniques.

Metallurgical Problems

Refractory metals like columbium (niobium), tantalum, molybdenum, tungsten, and their alloys have been contemplated for use in the critical portions of re-entry

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vehicles, but no satisfactory means of brazing these refractory metals for service above 2500 F was known.

The main problems in brazing refractory metals are not process problems. Suitable processes exist, although with some equipment limitations. The basic limits to refractory-metal brazing are posed by three metallurgical problems: (*a*) Recrystallization and ductile-brittle transition temperatures; (*b*) the formation of intermetallics between refractory metal and brazing filler metals; and (*c*) the relative weakness of brazing filler materials at elevated temperatures.

Recrystallization and Ductile Brittle Transition Temperature. The detrimental effects of recrystallization which occur with the refractory metals are not serious as far as a nonload-bearing application in a metallic heat-shield is concerned, but they are of vital concern in fabrication. However, with the advent of commercially available refractory alloys the brittle transition temperatures are constantly being lowered below room temperature. The transition from ductile to brittle behavior is very pronounced in the body-centered cubic metals—the family in which the refractories fall.

Formation of Intermetallics. The formation of brittle intermetallics between refractory metals and their alloys and brazing filler metals is harmful. These may fracture at relatively low loads when the joint is stressed. Just as recrystallization may occur either during brazing or during elevated-temperature service, intermetallics will form under either condition.

Relative Weakness of Filler Materials. The relative weakness of filler materials at elevated temperatures poses a basic limitation for the use of brazed refractory-metal assemblies. Most of the nickel-base filler materials used at elevated temperatures melt in the 1800 to 2100-F range, where the superior elevated-temperature strength of refractory metals such as columbium begins to manifest itself. Special high-melting-point filler materials for refractory metals are clearly indicated, provided, of course, that they do not cause refractory-metal recrystallization or form intermetallics with the metal. These are difficult requirements, and no one material today completely satisfies all of them.

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A suitable brazing material must possess structural strength at temperatures up to about 3000 F. In addition, it must form a ductile joint which will not become embrittled by high-temperature service. Noble-metal-base alloys have been suggested previously, for example, 70 Pd-30 Cu, 70 Pd-30 Ni, 84 Ni-16 Ti, and 52 Cb-48 Ni. However, these alloys form brittle compounds with the parent metals, thereby seriously reducing the strength of the brazed joint.

Research and Development Structures Program

Metal radiative-shield sandwich-type structures capable of withstanding 3000 F for short periods of time were a goal of a Research and Development Structures Program. The brazing of refractory metals such as molybdenum or columbium was evaluated with emphasis on selecting brazing alloys for columbium rather than molybdenum because it has better fabricability characteristics and is more resistant to oxidation. Although the strength of columbium is lower, there are commercially available alloys, namely, du Pont D31 (10 Ti-10 Mo) and Fansteel No. 82 (33 Ta-0.7 Zr) which approach the strength of molybdenum. Also embrittlement of columbium does not accompany recrystallization as in the case of molybdenum. However, some columbium alloys do embrittle and a careful selection must be made. Although columbium is more oxidation-resistant than molybdenum, a protective coating must be employed at the proposed service temperature. Columbium and its alloys are more affected than molybdenum by diffusion of interstitials, chiefly oxygen, which severely embrittle the metal. Although each metal has undesirable attributes, the design of the radiative shield was such that columbium offered fewer problems in fabricating the final product, a sandwich-type structure capable of withstanding 3000 F.

The first high-temperature brazing experiments were conducted in a cold-wall 3500-F vacuum furnace. Pure-columbium-joint specimens were brazed. At this time only two braze alloys were evaluated, namely, pure platinum and pure titanium. These specimens were brazed at 3300 F and microscopic examination indicated that pure titanium was far superior to platinum as a braze alloy. Initial studies indicated that platinum eroded the columbium-base metal severely and also produced a very brittle joint, Fig. 1. Titanium, however, alloyed slightly with the base metal and produced a ductile and strong joint, Fig. 2.

After the initial brazing studies, a survey of possible high-temperature brazing alloys for columbium and its alloys resulted in the selection of several for evaluation, Table 1.

Commercially pure titanium, designated A-40 and A-55, was used, with a yield strength at 0.2 per cent offset of between about 40,000 to about 80,000 psi, and a melting point of about 3300 F plus or minus 25 deg.

In addition to metallurgical compatibility with the refractory metals, titanium possesses a comparable coefficient of expansion which further insures the soundness of the brazed joint.

The base alloys of columbium, du Pont D31 and Fansteel No. 82, were brazed with each of the afore-mentioned brazing alloys. The discussion will be mainly on Fansteel No. 82 with which most of the work was done.

In general, the results of these preliminary tests look very promising. Of the filler alloys selected for evaluation, only the 90-platinum 10-rhodium alloy was de-

Fig. 3 Interior of the cold-wall, high-temperature, internal-element vacuum furnace. Both front and rear doors are open. Each has a heating element mounted on it. With the doors closed, the furnace working area is heated from all six sides of a cube.

Fig. 4 Metal radiative heat shield consists of two formed cups with a honeycomb filling (shown in cutaway piece)

leted because it severely erodes the base metal and produces a very brittle joint. Titanium appeared to be the best brazing alloy. It produces a strong, yet ductile, joint and dissolves the base metal to a slight degree to form a solid-solution-type alloy with columbium. This probably can be controlled by more closely pinpointing the brazing temperature. Palladium, platinum, and 90 per cent platinum, 10 per cent iridium all tend to dissolve the parent material to an extent, but produce relatively brittle joints. Therefore at the present time pure titanium appears to be the optimum braze alloy for Fansteel No. 82.

Vacuum Furnace

The recently installed cold-wall, high-temperature, internal-element, vacuum furnace used for this brazing is unique, Fig. 3. This resistance furnace is designed for sintering, brazing, heat-treating, and annealing at 4500 F with pressure in the 0.1-micron range. No nonmetallic refractories are used inside the vacuum chamber (with the exception of thermocouple and power feed through insulators, which are shielded and remain cold). The use of metal heat shields to control heat loss allows operation at high temperatures and low pressures.

The furnace heat whose interior dimensions are $12 \times 12 \times 12$ in. can maintain 4000 F for periods of 1 hr and a maximum of 4500 F for short periods, although this reduces the service life of the heating elements. A vacuum pressure of 1×10^{-6} mm of mercury is required. The power control is a saturable-core reactor while the temperature control is recorded with thermocouples.

The chamber opens on either side of the helsl to facilitate placement of the work charge and the maintenance of the elements and shields.

Nearly all conventional rod, wire, or ribbon resistance-heating elements require refractory insulation that is exposed to the radiant heat. This is used to isolate the heating elements electrically from each other and from ground. Nonmetallic refractory insulation is not used since it will not withstand temperatures of 4000 F.

The heating elements are strips of tantalum located on all six sides of the working area. The heater strips are corrugated for strength and supported by shielded water-cooled copper posts. These elements operate on low voltage to prevent any possibility of arcing between elements or other furnace components. Furthermore, thermal-expansion problems are alleviated by the unique serpentine design in the heating elements. The radiation losses from this type of element are less than with rod or ribbon elements as reflected heat from the work-charge passes between the ribbon or rod element to the heat shields. Therefore, with the closely spaced, corrugated, serpentine-designed heating element, radiation and conduction losses are held to a minimum. Distortion, which materially affects the element and is caused by inherent differential expansion, is practically nil with this new type of element design.

The radiation shields are arranged in packs. Each package assembly consists of three tantalum and three molybdenum shields secured together with pins. These assemblies are mounted from the walls of the tank on brackets.

Power is brought to the heating element tabs by means of water-cooled copper bus bars to which the heating elements are bolted. An additional water-cooled copper bus bar supports the heating elements at intervals to prevent excess distortion and growth.

Tungsten rods located on 4-in. centers extend through the bottom heat shields and heating elements to support the work jig and the assembly.

The total power input is 200 kw. The power input is

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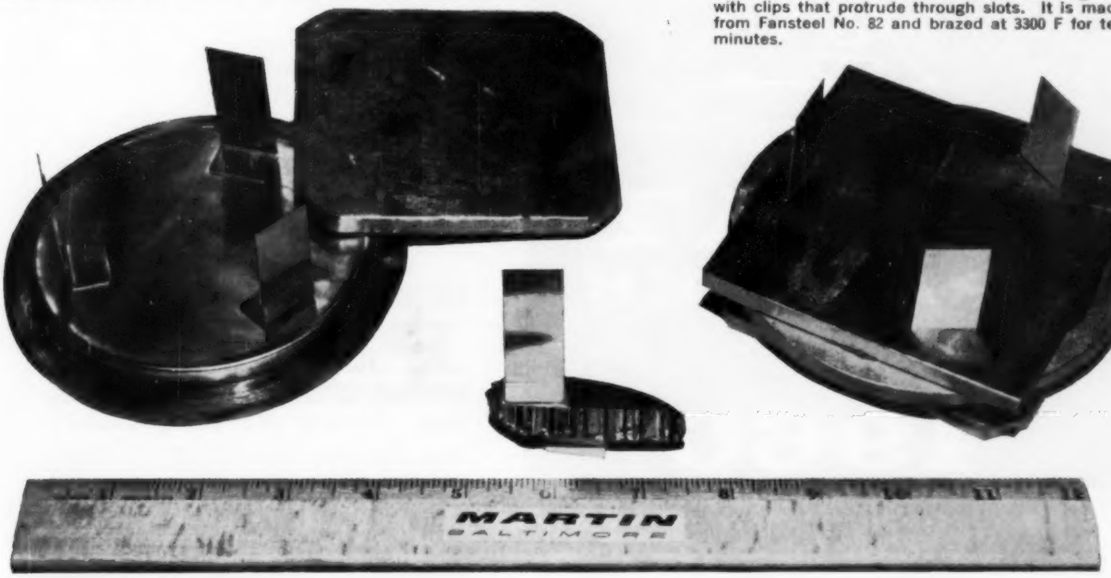
Fig. 5 Heat shield is assembled in a brazing tool with clips that protrude through slots. It is made from Fansteel No. 82 and brazed at 3300 F for ten minutes.



divided equally on all six sides. Saturable-core reactors control the voltage to the heating elements in each zone.

To overcome difficulties with condensation in optical-pyrometry methods, and the embrittlement and low thermal emf of tungsten-molybdenum and tungsten-iridium thermocouples, a tungsten-rhenium thermocouple was used.

Initially, the thermocouple insulators were thoria. However, recent tests have indicated that thoria becomes extremely conductive at approximately 2800 F. Therefore a sheathed tungsten-rhenium thermocouple is now being used. The sheath material is tantalum while the insulation material within the sheath is beryllium oxide. Tungsten-rhenium thermocouples with beryllium-oxide insulators have been evaluated and have performed satisfactorily.

The power supply of the unit is capable of delivering 242 kw. The furnace is capable of using 225 kw, the vacuum pumps use 15 kw, and the control panel 2 kw. To date, no more than 135 kw have been required to operate the furnace and its accessory equipment.

A minimum pressure of 40 psi and water temperature of 60 to 85 F are required to produce a flow of approximately 100 gpm when the furnace is operating at 4200 F.

The heating elements are made in sections; thus only those portions that are defective need be replaced.

If the entire set of heating elements needs replacing, approximately 16 man-hours are required to do the job. However, this operation shouldn't occur very frequently since 75 hr at 4000 F and a minimum of 250 hr at 3500 F can be expected.

Tooling

The tooling material for use at 3000 F is limited, Table 2. Refractory metals and/or their alloys, ceramics, graphite, newly developed carbides or borides, and refractory-coated graphite are the only materials available since the furnace temperatures are beyond the limits of commonly used tooling materials of today.

Of these materials ceramics, which are capable of withstanding 3000 F such as alumina, zirconia, and beryllia, cannot be used in vacuum atmospheres due to contamination, reaction with refractory metals, and thermal expansion and contraction. Although graphite has excellent dimensional stability, it embrittles the refractory metals which are the heating-element material. The newly developed carbides and borides (zirconium boride, zirconium carbide, titanium carbide) are still in the developmental stages. This leaves only the refractory metals and their alloys. The metal or alloy to be used will depend entirely on the assembly to be built.

For example, the metal radiation shield, Fig. 4, was composed of Fansteel No. 82. This is primarily a columbium-base alloy (66 per cent). Since its thermal-expansion rates had not been published it was unavailable in 0.250 gage; pure columbium was used as the tooling material. The coefficient of thermal expansion is close enough to that of Fansteel No. 82. After brazing at 3300 F, the components were held within ±0.010 flat tolerance. Thus it appears that tooling material for 3000-F brazing can be designed and built with refractory metals, Fig. 5. However, the costs of the basic tooling material and the manufacturing operations to utilize it are high.

Conclusions

With the advent of furnaces that can attain 4000 F in a controlled-vacuum atmosphere and the development of brazing alloys that produce ductile joints of strength equal to the parent metal, the refractory metals can be used for fabricating the required components of missiles or space vehicles that will operate in what are—by comparison with ordinary uses—abnormal environments.

While the present cost of fabricating these exotic materials seems high, the important thing is that a process has been developed. By the time space vehicles are commonplace, these costs will be in line with the over-all price of the vehicle.

A Review of HEAT TRANSFER Literature[1] 1960

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PART 1

New theories are being evolved and old ones checked and checked again. Analytical and experimental studies are the prerequisites to the calculation of heat transfer.

Heat-transfer problems have to be solved in almost every engineering activity. They become crucial for modern developments like high-speed aeronautics and space flight. This is the reason research activity in heat transfer is strong as evidenced by the growing number of publications in this area. Space limitations have prevented us from including all references in this literature survey.

The National Heat Transfer Conference, organized as an annual event by The American Society of Mechanical Engineers and the American Institute of Chemical Engineers, was held in August, 1960, at Buffalo, with an attendance of almost 1000 persons in twelve crowded sessions. A forum for discussion of heat-transfer problems on an international basis will be provided by the International Heat Transfer Conference which will be held in September, 1961, at Buffalo. The preceding international conference, held at London in 1951, brought together scientists and engineers from all nations engaged in heat-transfer research.

A new magazine, the *International Journal of Heat and Mass Transfer*, published by Pergamon Press, Oxford, England, started publication in 1960 with three issues containing contributions from France, Germany, Great Britain, Japan, Russia, and Switzerland as well as from the U. S. A number of new books present either an introduction to, or a cross section through, the present state of the heat transfer field or related areas [1–10].[5]

We have introduced in this review a new section discussing thermodynamic and transport properties because such properties are more and more intimately connected with heat-transfer considerations. The available space permitted only the coverage of fluid properties on the basis of a small number of selected papers. They contain correlations and analytical predictions for a range from 3 K to 15,000 K, whereas experimental determinations were mainly restricted to temperatures below 1300 K.

A significant increase in the number of papers dealing with radiation becomes immediately apparent by a comparison with last year's review.[6] It is caused by the fact that space applications have generally to rely on radiation for energy transport.

Several reports describing experiments on various models in supersonic or hypersonic flow have found their way into the open literature. Detailed observations and measurements have made it possible to develop analytical models for the description of flow and heat transfer in separated regions. This development has been favored by the fact that engineering interest now includes low-Reynolds-number flow which is more amenable to analytic approach. A well-developed model describing qualitatively the transition process from laminar to turbulent flow has evolved from flow observations and hot-wire measurements.

A significant engineering advance in high heat-transfer coefficients for evaporation and condensation processes has been possible by selection of proper geometries (Fig. 1). A considerable number of papers, mainly experimental, covers the area of heat transfer with change of phase, obviously due to the complexity of this process which prevents analytical predictions in most of the cases.

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Contributed by the Heat Transfer Division of The American Society of Mechanical Engineers. Part 2 will appear in the forthcoming August issue of Mechanical Engineering.

[5] Numbers in brackets designate References at end of paper.

[6] Mechanical Engineering, August, 1960, pp. 47–61.

Conduction

The problem presented by conduction, steady and unsteady, through a composite wall: Extending the generalization of classical problems to include the composite-layer case [34A], Vodicka also considers the steady temperature distribution in the specific geometries of an infinite plate [35A] and hollow, infinite, circular, and elliptical n-layered cylinders [36A]. A semi-infinite, 2-layer body of uniform temperature suddenly encounters a fluid of different temperature in [26A] where the heat transfer between fluid and surface is described by a constant film coefficient. For designing a thermal barrier, [31A] uses separation of variables and matrix methods to solve the case of a 2-layer slab, one face of which is adiabatic, the other subjected to sinusoidal temperature variation. It is noted [5A] that the problem is solvable for a triangular heat impulse through analogy with an appropriate electrical circuit. Steady-state temperature distribution and calculated heat transfer through honeycomb-type sandwich panels for simultaneous radiation and conduction agree to within 15 per cent [32A].

Unsteady-state heat conduction: For a semi-infinite medium, [6A, 4A] impose boundary conditions involving temperature in a nonlinear manner which, in some cases, lead to an integral equation for the surface temperature; [25A] imposes various heat inputs over the surface; and [15A] presents a scheme for computing thick-wall temperatures for arbitrary variations of adiabatic wall temperature and heat-transfer coefficient. The heating of a plane wall behind a constant-velocity plane shock moving parallel to it into a stagnant gas is accurately represented by integral equations solved by successive approximations [33A]. Approximate solutions for the melting of a semi-infinite slab are noted and compared to exact solution [8A].

Cooling of solid particles in a fluid by suitable assumptions reduces to a system of linear, simultaneous equations with constant coefficients, solvable as an eigenvalue problem [24A]. For transient heat conduction in hollow cylinders and slabs, [14A] presents dimensionless temperature for range of heat input for isotropic, constant properties, adiabatic boundary conditions. Disregarding evaporation, [18A] investigates the unsteady temperature and humidity fields in the vicinity of an infinite plate. For variable properties, [13A] considers conduction through a semi-infinite gas medium having a uniform initial and constant boundary temperature, determining integrated air-thermal conductivities for oxygen-dissociating temperatures.

Additional transient studies, involving melting or freezing: After onset of melting, [7A] describes a simple successive approximation solution of ordinary, nonlinear, differential equations which permits the heat input to be arbitrarily varied to a semiadiabatic slab. The melting rate of a finite slab (initial temperature uniform and below melting point, one face adiabatic or constant temperature) for constant heat input is solved approximately by the heat-balance integral [11A]. Reference [20A] extends previous work to include melting effect; and [19A] removes the prior condition that a molten region exist. Heat flow into an infinite, homogeneous medium from a moving heat source, represented by a finite cylinder with time-dependent radius, is determined [1A] with specific application to secondary oil recovery by underground combustion. A related cooling problem [16A] concerns the steady addition of metal at uniform temperature to an isothermal liquid-metal column of different temperature, the bottom temperature of which is constant. Treating conductivity as arbitrarily temperature-dependent, [10A] considers transient conduction in a cylinder with one moving boundary using infinite differences.

Transient conduction, with heat source, is examined for the case of a cylindrical, isothermal source in a semi-infinite body of constant boundary temperature, using integral equation method to yield temperature field and heat flux [17A]. The transient temperature distribution in a uranium rod depends on heat source and removal rates according to [21A]. In the same vein, [28A] examines the two-dimensional heat-conduction problem for a uniform volume heat source, cooled by fully developed flow of coolant in circular passages arranged in triangular or square array. The generalization of heating and cooling rates, when the temperature rate of change describes all points in the system and is not influenced by the original temperature distribution, has application to temperature measurements and thermal behavior of complex systems [9A].

Steady-state heat conduction in a circular cone with initial, nonuniform, surface temperatures is solved rigorously by [23A]. Reference [29A] solves numerically the steady, linear, conduction equation when heat generation and conductivity are arbitrary functions of temperature. Using a heat-balance error to correct the choice of gradient at the surface, [27A] gives steady-state results for a bar losing heat by radiation. An implicit numerical method for solving the two-dimensional conduction equation includes exact solution in linear case, and uses an iterative scheme to extend the method to nonlinear cases [2A].

Variations and extensions of the fin problem occur in [22A] which considers thin, rectangular, triangular, and optimum fins with internal heat generation, and in [12A] which discusses the relation between heat transfer and thermal stress in fins. In this connection, [37A] notes the effect of unsteady thermal stress fields upon the formulation of the conduction equation.

Reference [30A] considers the inverse problem of heat conduction—to determine the surface heat flux knowing an internal temperature variation with time.

Finally, [3A] treats the problem of predicting, and correcting for, temperature disturbance caused by thermocouples placed beneath a surface of a heat sink (or calorimeter) exposed to heat flux during re-entry.

Channel Flow

Laminar heat transfer in the thermal entrance region of ducts: The classical Graetz problem, in which a hydrodynamically developed isothermal flow enters a heated section of duct, has been analyzed by new calculation methods and for a broader class of boundary conditions. The eigenvalue problem associated with the solution of the energy equation for the parallel-plate channel or circular tube with uniform wall temperature has been

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solved to ten-figure accuracy [6B]. This same method of analysis is applied to prescribed symmetrical or unsymmetrical heat transfer at the walls of a parallel-plate channel [7B, 8B, 9B]. The effect of heat conduction from the heated fluid into the unheated starting length is examined for a parallel-plate channel and found to be important only at low Peclet numbers [2B]. More accurate solutions of the energy equation very near the entrance section of tubes and channels were obtained by abandoning the eigenvalue approach in favor of a boundary-layer formulation [26B, 25B].

Problems of the Graetz type have been considered for laminar flow in noncircular ducts. In one case, the eigenvalue problem for a square duct was attacked by a variational method [36B]. In another, the eigenfunctions for a rectangular duct were expanded in terms of slug-flow eigenvalues [14B]. An attempt has been made to bring together laminar heat-transfer results for various noncircular ducts, but notational difficulties make the final correlations difficult to interpret [39B].

As a variant of the Graetz problem, the simultaneous development of velocity and temperature distributions in the entrance region of tubes and ducts has been analyzed [35B, 29B, 38B]. The first two of these are highly theoretical and are not easily applied. However, [38B] presents Nusselt number results in a simple form showing favorable comparison with air data [4B].

Fully developed laminar heat transfer is analyzed in annuli with blowing and suction for the condition of constant longitudinal mass flow [20B]. A circumferentially variable heat flux may lead to large circumferential variations in wall temperature [30B].

Two interesting problems in laminar heat transfer in tubes relate to the effects of nonisothermal chemical reactions [10B] and to non-Newtonian viscosities [28B].

In contrast to the purely analytical studies for laminar flow, the turbulent case has been treated both analytically and experimentally. For flow in tubes, analytically derived Nusselt numbers for both the entrance and fully developed regions are only slightly different for the boundary conditions of uniform wall temperature and uniform wall heat flux when the Prandtl number $\geq$ 0.7 [34B]. An analysis gives heat-transfer results when there is an internal heat generation in the flowing fluid [33B]. A critical review of the analogies between heat, momentum, and mass transfer resulted in a correlation for turbulent heat transfer in smooth tubes covering Prandtl (or Schmidt) numbers between 0.46 and 3000 [27B]. Experiments were made on the turbulent flow of gaseous hydrogen in circular tubes at high pressures and high heat fluxes [17B, 24B].

An extensive experimental program covering the Reynolds-number range 20,000 to 250,000 produced data for heating and cooling of air and carbon dioxide with large gas-to-wall temperature differences [41B]. It was found possible to correlate data for the low-temperature dissociating system $N_2O_4 \rightleftarrows 2\,NO_2$ by using suitably averaged equilibrium properties and a mean kinematic viscosity in the Reynolds number [5B]. Thermal entrance-region effects were clearly delineated in an experiment with air in the transition and low-turbulent regimes [16B]. In a fundamental experimental study, temperature and velocity profiles were measured in the thermal-entrance region of a circular tube (hydrodynamically developed velocity) [1B]. A complementary analysis of the distribution of the radial heat flux [11B] served in analyzing the data.

Turbulent heat transfer in noncircular ducts: Calculation of heat transfer at one wall of a parallel plate channel (other side insulated) by using the heated periphery in the evaluation of the hydraulic diameter was analytically explored [19B]. A critical survey of heat-transfer data for the annulus led to the conclusion that heat transfer at the outer pipe surface is calculable using the hydraulic diameter with *wetted* perimeter, but that there is no simple rule for the inner pipe [40B]. Analytical heat-transfer predictions for turbulent flow in equilateral triangular and square cross sections were calculated by applying generalized velocity and temperature profiles from circular tubes [13B]. Experiments for air flowing in an electrically heated duct of isosceles triangular cross section (11.46-deg apex angle) reveal thermal entrance lengths in excess of 100 diameters [15B].

Unsteady laminar and turbulent heat-transfer results corresponding to prescribed time variations of tube-wall temperature were derived by solving the time-dependent energy equation for the fluid [32B, 37B]. Another approach assumes that the turbulent heat-transfer coefficient is unchanging with time and position and computes the temperature response of the fluid and tube wall to changes in internal heat generation in the wall [3B]. Large increases in heat transfer can be attained by vibrating a duct wall normal to the direction of the main flow [31B].

Swirling and vortex flows: Experiments with water and air flowing through pipes with several types of inserts and swirl promotors show both large increases in heat transfer and reductions in the pumping power per unit of heat transfer [21B]. Additional experimental results on this same problem are reported in [18B]. Electrically heated rotating tubes and annuli with throughflow provided heat-transfer data for water characterized by three distinct flow regimes depending on rotational speed [22B].

Two analytical treatments of the vortex tube have appeared, neither fully predictive. In one, an inviscid flow model is assumed which combines a vortex, a sink, and a uniform axial flow [23B]. In the second, a turbulent compressible vortex is postulated [12B].

Boundary Layer Flow

Boundary-Layer Solutions. The main emphasis in recent boundary-layer heat-transfer analysis has been on approximate solutions and calculation methods. However, some work relating to exact solutions and classical-type problems continues. Among these, the requirements for similar solutions of the energy equation were examined for laminar flow [58C]. Adiabatic wall temperatures for laminar flow of high-Prandtl-number fluids over a flat plate have been re-examined [37C] and more accurate results calculated. An analysis has provided

the heat-transfer response of a cylinder or sphere immersed in a fluctuating laminar flow with small mean velocity [27C]. There has been further study of the wall jet (a free jet bounded on one side by a wall) relating to compressibility and heat-transfer characteristics [5C].

A study of Reynolds' analogy for the laminar flat-plate boundary layer with blowing reveals that the ratio of Stanton number to friction factor increases with the blowing velocity [20C]. Mangler's transformation, which reduces axial-symmetric boundary-layer problems to plane problems, has been successfully applied in the analysis of the high-speed, compressible boundary layer on a cone, and results were obtained utilizing prior flat-plate solutions [23C]. The unsteady flow and heat transfer on a flat plate moving with time-dependent velocity into a compressible fluid has been attacked using a series-expansion method [19C].

The calculation of heat transfer from nonisothermal surfaces: A set of variable wall-temperature solutions for laminar and turbulent flow over a flat plate is tabulated [4C]. Application is made to laminar flow over a plate whose surface has two separated isothermal zones and is otherwise insulated; mass-transfer experiments with naphthalene agree well with the theory [53C]. Lighthill's superposition integral for computing laminar heat transfer with variable wall temperature and variable free-stream velocity has been generalized to include the effects of aerodynamic heating [34C].

The compressible laminar boundary layer with variable free-stream velocity and isothermal wall has been analyzed to various degrees of approximation. In one case, Stewartson's transformation is used to reduce the compressible conservation laws to those for an incompressible fluid, and a series solution obtained [42C]. In a second study, the energy equation is eliminated by writing the temperature as a quadratic function of the velocity, which is in turn approximated by a quintic polynomial in the normal co-ordinate [16C]. Practical calculation procedures for determining the laminar heat transfer on blunt hypersonic vehicles are presented in [41C] and [65C].

An initial study of laminar non-Newtonian boundary-layer flow and heat transfer is based on the assumption that the shear stress is proportional to a power of the velocity gradient [1C]. Also of particular interest are the finite-difference solutions for axially symmetric blunt bodies which were carried out without similarity assumptions [33C]. Laminar flow and heat transfer on a flat plate with wedge-shaped grooves in the flow direction were analyzed by the Karman-Pohlhausen method [28C].

Turbulent boundary layers continue to resist exact solution, but there is considerable activity in finding approximate results. Deissler's eddy-diffusivity expressions form the basis of an analysis of high-speed flat-plate flow and heat transfer under conditions of variable fluid properties and frictional heating [17C]. Results are given for Mach numbers up to 20. Another approach to this same problem starts by analyzing velocity data, and obtains the variation of the shear across the boundary layer [54C]. This information is then utilized to integrate the energy equation for the flat plate [54C], [55C]. This same paper [55C] evolves a relationship between compressible and incompressible turbulent boundary layers with pressure gradient and Prandtl number not equal to unity. The turbulent compressible boundary layer over a slightly yawed cone is made tractable by assuming 1/7-power law for the velocity distribution and a modified Blasius shear law [7C]. For a highly cooled, blunt-nose body under hypersonic conditions at an angle of attack, it is demonstrated that the cross-flow velocity is negligible and that heat transfer is calculable by two-dimensional methods [62C]. A relatively simple relation for calculating turbulent heat transfer on a blunt body has been derived by postulating a simple, but unsupported, relation between enthalpy thickness and momentum thickness [64C].

Three interesting Russian papers relating to approximate heat-transfer calculations have appeared. For the laminar boundary layer with arbitrary free-stream velocity, a method is proposed in which successive moments of the energy equation are taken [51C]. Various form factors (i.e., thickness parameters) are needed and these are obtained from flat-plate and wedge-flow solutions. A second study treats the same problem, but extends consideration to laminar, transition, and turbulent flows [68C]. A third paper considers the heretofore-neglected effects of density fluctuations on compressible turbulent flow and heat transfer about a flat plate [32C].

Dissociation and Chemical Reactions. Fourier's equation, describing heat conduction in a medium with variable heat conductivity, can be made linear by introduction of a heat-flux potential defined as the integral of heat conductivity over temperature. This equation is used to study analytically unsteady heat transfer in a stationary gas with chemical reactions [26C]. A considerable number of papers are concerned with the prediction of laminar heat transfer to high-speed objects, like missiles or satellites, moving or re-entering through the atmosphere. The air surrounding the object is then heated to such a degree that dissociation of the molecules may occur. Whether chemical equilibrium or frozen condition with regard to dissociation of oxygen exists is investigated by a comparison of a characteristic residence time of the atoms within the boundary layer to a characteristic chemical reaction time [2C]. The simultaneous effect of a finite recombination rate of oxygen atoms and of fluid injection has been calculated for Couette flow and for a flat plate of infinite extent suddenly set in motion (Rayleigh's problem) [9C]. A similar calculation using an integral method and the assumption that Prandtl and Lewis numbers are equal to one and that the dissociation is a second-order reaction gave the result that, for Mach numbers between 10 and 20 and a flight altitude of between 50,000 and 200,000 ft, equilibrium is never approximated within the boundary layer on an adiabatic flat plate [11C].

A similar calculation for flow over blunt bodies is reported in two papers [61C, 12C]. Recombination may also occur on a catalytic surface even when the dissociation is frozen within the boundary layer itself. A calculation of such a situation assumes a first-order surface recombination, a constant Schmidt number, constant wall temperature, and a gas for which the product of density-times-viscosity is constant [10C]. The results are well approximated by a simple empirical equation. The postulate of local similarity and use of constant-property relations, into which the properties are introduced at a reference enthalpy, leads to heat-transfer information which is in good agreement with the results of more involved boundary-layer solutions [18C]. Tables have been prepared from which laminar skin friction and heat-transfer parameters can be read for flow of air with equilibrium dissociation over flat plates at angles of at-

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tack from zero to 50 deg for wall temperatures, from 1000 to 3000 R and free-stream velocities of 10,000 to 28,000 ft [48C]. Simple relations for properties of a dissociated gas with frozen chemical composition are shown [22C].

The chemical reaction of a gas released from a surface with a gas flowing in a laminar boundary layer over the surface occurs in a narrow reaction zone, provided the reaction rate is very rapid. The location of this zone is calculated [21C]. A corresponding experimental study has been reported [36C]. The derivation from basic principles of the energy equation of a chemically reacting gas flowing at a low density over a surface indicates that energy transport caused by shear work at the surface has to be considered when slip occurs at the surface [47C].

Magnetohydrodynamics. An excellent introduction into magnetogasdynamics and its possible aeronautical applications discusses the use of magnetic fields to modify the forces and heat transfer on objects exposed to the flow of a conducting fluid [50C]. The influence of a magnetic field on heat transfer has been calculated for a number of various geometries and laminar-flow situations: Flow between two infinite parallel plates with the plate temperature varying stepwise in flow direction and with a magnetic field normal to the planes [39C]; hypersonic flow in the region of a 3-dimensional stagnation point [30C]; wedge-type flow resulting in similar solutions for proper boundary conditions [31C]; flow past an infinite porous flat plate in the presence of a transverse magnetic field and with fluid ejection [25C]; steady and transient free convection on a vertical plate with a transverse magnetic field [24C]; convective motion of a conducting fluid between parallel vertical plates [44C]; free convection in the layer between a lower-heated and an upper-cooled surface [38C]; free convection of mercury in a closed circular tube with a transverse magnetic field [52C]. The analogy between the magnetic vector potential and the temperature field, which exists when the electric field in the flow is zero or negligible, has been utilized to obtain information on the magnetic field for various geometries [35C]. The stability of laminar flow in a boundary layer or channel, and the influence of a magnetic field, has been analyzed by an extension of Tolmien's method [46C]. One of the rare experimental studies in magnetofluidmechanics is reported [6C]. A hemispherical model of a eutectic alloy of bismuth with 117-F melting temperature was exposed to a stream of hot water and the melting process was filmed. A coil around the model support and a 6-volt battery generated a magnetic field of 5000 gauss in the water. The velocity in the molten layer decreased and the thickness increased when a magnetic field was applied. A preliminary report [56C] describes experiments on heat transfer to a water-cooled copper tube exposed to a carbon arc discharge with 7000-K temperature, or a water plasma jet with 14,000 K.

Experimental Investigations. A number of papers reported on experimental investigations measuring heat transfer in supersonic flow to objects with various geometries. Use of a shroud with proper design, surrounding the model, makes it possible to investigate large models in wind tunnels with restricted cross section [15C]. Laminar heat transfer on a cylinder normal to rarefied flow was found to be in good agreement with predictions by Lees' method [60C]. Use of the reference-enthalpy method and flat-plate relations based on local conditions satisfactorily described turbulent heat transfer on blunt objects [15C]. Simple approximate expressions were developed describing the maximum turbulent-boundary-layer heating rates on a hemispherical nose [3C].

Experiments on heat transfer in Laval nozzles with flow of superheated steam gave good agreement with a turbulent-boundary-layer method by Bartz, but showed considerable deviations from tube-flow relations [43C]. Measurements on heat transfer to cones arranged in supersonic flow with Mach numbers between 2 and 5 and with various angles of attack [8C, 29C, 59C] indicate that heat transfer at the stagnation line increased up to fourfold with increasing angle of attack. Skin friction in a compressible turbulent boundary layer on a cone is reduced by the injection of air, or Freon 12, and especially helium [40C]. The reduction was found to decrease with increasing Mach number. The effect of surface cooling on boundary-layer transition was studied on a 15-deg cone at Mach number 4 [66C]. Heat transfer to the leading edge of a wing exposed to a high-Mach-number flow can be considerably reduced if the leading edge is arranged oblique to the flight direction [14C].

Experiments on turbulent heat transfer from a non-isothermal flat plate established simple relations describing Stanton number [45C, 13C]. Experiments on heat transfer near a convex corner normal to the flow direction [67C] and near a concave corner parallel to the flow direction [57C] were reported. The effect of free-stream turbulence produced by a screen on a cylinder normal to the floor direction was investigated [49C]. Local heat-transfer coefficients on a surface, on which an air jet impinges normally, have been measured [63C].

Flow With Separated Regions

Analytical and experimental studies have considerably increased our understanding of the heat-transfer process in a separated region. The separated boundary layer behind a step in the surface contour can either be laminar or turbulent. Heat-transfer measurements [9D] in the region of a separated flow with laminar boundary layer agreed well with an analysis by Chapman. In flow with a turbulent separated boundary layer, experimental heat-transfer coefficients were considerably lower than calculated values [9D, 11D]. The shroud technique described in the boundary-layer section has been successfully applied to study heat transfer on the downstream part of blunt objects [2D]. Accommodation coefficients and Nusselt numbers have been determined for hypersonic gas flow normal to a cylinder from the free molecule to the continuum regime [13D], and also for a fluid with small Prandtl number [1D].

Pebble-bed heaters are widely used to generate a high-temperature gas stream, for instance, for supersonic wind tunnels. Experiments on such a heater [8D]

established a relation for the heat transfer to the packed alumina spheres in the heater. This relation is surprisingly close to the one for a single sphere. Experiments were also concerned with heat transfer to the wall surface in a packed bed [14D] as well as in the bed itself [4D]. An analysis on laminar flow through a pebble bed heater with internal heat generation (nuclear reactors) established the tendency to develop hot spots [5D]. A similar analysis allows calculation of the unsteady temperature distribution in a packed bed for any initial temperature distribution and temperature variation of the entering gas [7D].

Heat-transfer coefficients from a moving bed of quartz sand to the walls of a circular tube have been established [6D]. Measurements on heat transfer to the particles in a fluidized bed [10D, 3D] established heat-transfer relations, and a survey of previous experiments on heat transfer between a fluidized bed and a vertical tube resulted in two correlations—one for fine particles with predominantly viscous flow, and another one for coarse particles with predominantly inertial forces [12D]. Considerable deviations between the results of the various experiments demonstrate the relatively poor knowledge of this flow and heat-transfer process.

Transfer Mechanism

Knowledge of the laminar or turbulent state of the flow and of the transition location is one of the most important prerequisites to a prediction of heat transfer. Visual observation and hot-wire measurements contributed strongly to our understanding of the transition process [6E, 3E, 5E, 8E, 13E, 9E]. The following model of the transition process has evolved from these studies: Transition is usually initiated by instability waves which amplify in downstream direction and roll up into vortexes. Such vortexes with straight axes in shear flow are unstable and deform in the way that the axis builds loops. At the loops, the fluctuations are especially intense and cause the vortex to break down rapidly into finer and finer vortexes (turbulent spots). This transition process occurs also in a separated laminar boundary layer [10E]. The reverse transition from a turbulent into a laminar boundary layer can occur under specific situations [14E].

The effect of an isolated [1E] or distributed [17E] roughness on transition in a supersonic flow can well be characterized by a roughness Reynolds number based on roughness height and velocity at roughness height for subsonic flow, or sound velocity corresponding to the state at roughness height for supersonic flow. A shock tube is an excellent tool to study heat-transfer and boundary-layer transition at high Mach numbers and temperatures [7E]. The turbulence intensity at the center of a flame-holder plane was found to decrease when the ratio of mean free path length to Kolmogoroff scale exceeded a value 0.01 [11E].

Analytical work on the transition process has proceeded [4E] and it is claimed that it now predicts the end of transition as well as its initiation [15E]. The theory of decaying homogeneous turbulence was improved by inclusion of quadruple correlations [2E]. The ratio of eddy diffusivities for momentum and heat is predicted as one by an analytical study [16E]. Van Driest's relation for the friction factor for turbulent flow near a wall is extended to flow at high Mach numbers and large temperature differences [12E].

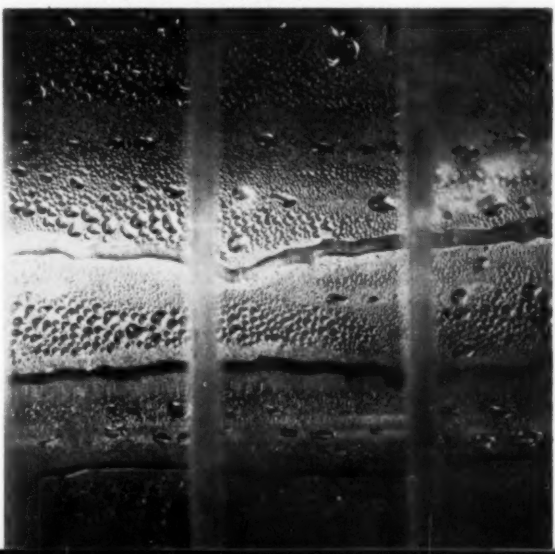
Natural Convection

Analytical and experimental activities covering a broad range of problems in natural convection and combined natural and forced convection have been reported. Among the analytical studies are boundary-layer problems. The wall-temperature variations which permit steady and unsteady similarity-type boundary layers were examined [42F] in a formal manner, but without numerical solutions. Two improvements in the integral method of solution (i.e., Karman-Pohlhausen) are proposed. In one, velocity and temperature profiles are used which contain both exponentials and powers of the distance from the wall [9F]; in the second, the boundary layer is subdivided into two zones depending on the relative importance of various transport mechanisms [4F].

Generalization of a previous integral solution is made to provide the wall temperature corresponding to an arbitrary variation of wall heat flux [1F]. The natural convection in a heated plume (jet) which rises above a horizontal wire has been analyzed by similarity solutions [5F, 34F]. Blowing or suction through a vertical isothermal plate is found to alter significantly the heat transfer [6F]. An integral method is utilized to study the effects of a horizontal magnetic field for the case of an isothermal vertical plate [15F]. Conditions have been derived under which unsteady natural convection in gases can be treated as quasi-steady [37F].

Several papers relate to the analysis of combined natural and forced convection. The flow and heat

Fig. 1 Mixed dropwise and film condensation on a smooth chrome-plated surface (Reference 21J, Part 2).



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transfer in a vertical tube with a linear temperature gradient in the vertical direction have been solved (once again) by direct mathematical methods [26F]. A new approach appropriate to this thermal boundary condition uses complex variable theory and is illustrated for circular [38F] and rectangular [39F] cross sections. Another method for this type of problem is based on successive use of finite Fourier and Hankel transforms [23F] and solutions are given for the circular sector.

Analytical studies have been performed to determine the interaction of a transverse (i.e., horizontal) magnetic field on the flow in a vertical tube [35F] or parallel-plate channel [33F]. A correction formula for small buoyancy effects in fully developed laminar flow and heat transfer in a *horizontal* tube has been found to involve the product of the Reynolds and Raleigh numbers [27F]. Buoyancy effects have also been studied for low Reynolds number flow about a sphere for both aiding and opposing conditions [21F].

The thermosyphon, which is a heated tube closed at the bottom and open at the top to a cooled reservoir, has been analyzed for the condition of a small angle of tilt relative to the vertical [22F]. Closed-loop natural convection inside a horizontal cylinder whose temperature varies sinusoidally over the surface is studied by an integral method assuming a boundary layer near the wall and a rotating core [10F]. A mathematical study has been made of the uniqueness of solutions for weak (low Grashof number) convection [8F]. The hot gases produced by a fire experience an upward buoyant force. The characteristics of the ensuing turbulent natural-convection flow are predicted for a fire of arbitrary size in an atmosphere of arbitrary lapse rate [28F]. An order of magnitude estimate leads to the conclusion that natural convection caused by centrifugal forces (e.g., internal cooling of turbine blades) can be important even if the forced-convection mainflow is turbulent [43F]. A new correlation formula is proposed [16F] for predicting over-all heat transfer from vertical plates and horizontal cylinders over the Grashof-Prandtl range from 10^{-7} to 10^{12}.

Interest, both analytical and experimental, continues in the Bernard problem, wherein a thin horizontal layer of fluid is heated from below. For sufficiently large temperature differences, the quiescent state becomes unstable and fluid motion in various cellular patterns sets in. A nonlinear theory is advanced to explain the preference for hexagonal cells [31F]. For such a cell pattern, the streamline pattern at the point of instability has been derived [32F]. The heat transfer through such a flow has been determined [29F] and the effects of a superposed magnetic field studied [29F]. When the heated layer is subjected to a time-dependent body force, the Rayleigh number at which instability sets in is found to be much higher than in the steady case [11F].

Another interesting variant of the Bernard problem is the superposition of a rotation about the vertical axis of the heated fluid layer. If a metallic liquid such as mercury is thus heated and rotated, the flow pattern at the onset of instability is characterized as over-stable oscillations. The characteristics of this flow pattern are explored experimentally [30F] and the heat transfer determined [13F].

A large increase in free-convection heat transfer near the critical point has been reported in past investigations. Additional experiments to explore this phenomenon have been undertaken. In one test, an electrically heated horizontal wire was immersed in Freon 114A [14F]. Visual observations, at pressures beyond the critical, revealed bubblelike aggregates (Fig. 1), but there was no large heat transfer increase as in nucleate boiling. A second experiment carried out with Freon 12 in a natural-circulation loop also failed to find dramatic increases in heat transfer [17F].

Experiments on unsteady free convection: A vertical plate immersed in water was subjected to a step-function change in wall heat flux [12F]. The question of whether the transient surface temperature can overshoot the steady-state value was further explored with the aid of an electric circuit analog [2F]. This apparatus was used to analyze overshoot data from an electrically heated wire immersed in a sucrose solution [3F]. Disturbances have been set up in a free-convection boundary layer by periodic pulsing with a fine heated wire, and the resulting boundary-layer oscillations observed with an interferometer [18F, 19F]. Photographic techniques have also been used to observe the effect of a sound field on free convection about a horizontal cylinder [7F].

Steady-state natural-convection experiments have been carried out. The utility of the interferometer as a research tool is discussed and illustrated by photographs of the temperature field about various plates and cylinders [36F]. The measured effect [24F] of tilting a liquid-filled thermosyphon is to decrease heat transfer for small tilt angles (in contradiction to reference [22F]) and to increase heat transfer at larger angles of tilt. Steady-state heat losses from an inclined tube, heated at the base and filled with air, are reported as a function of inclination angle, tube diam, and wall conductivity [20F]. No consistent trend with angle is apparent. Temperature distributions and heat transfer have been determined for natural convection within a horizontal cylinder, the two vertical halves of which are maintained at different temperatures [25F]. A detailed investigation of the mean and fluctuating temperatures above a horizontal heated flat plate gave insight into the structure of the turbulent convection [40F]. The heat-transfer characteristics of spheres, both for purely natural convection [41F, 44F] and for combined natural and forced convection [44F], have been furnished by experiment.

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Fig. 1 A new concept in ocean transport—a flexible barge to carry oil (the barge need not provide buoyancy). Here, the seagoing container is shown tracking the tug so closely it could be turned around in a river only twice as wide as the barge is long.

"DRACONE" FLEXIBLE BARGES

By H. W. Hall,[1] Ministry of Supply, London, England

This nonrigid, ocean-going container for oil is called "Dracone" because of its similarity to a serpent (Greek—drakon). Forty-ton-capacity units have been built and are undergoing tests.

After the international crisis, of late 1956, involving the Suez Canal, the problems led Hawthorne, Taylor, and Shaw [1][2] to the conclusion that a nonrigid towed vessel offered many advantages for ocean transport of oil.

As described by Hawthorne [1], since oil is less dense than water, the oil-transporting vessel needs to provide no buoyancy for the cargo, only simple means to contain it. Again, it is not essential for such a floating container to be a rigid structure. A flexible structure which could conform to wave motion would be subjected to far less mechanical stresses, and thus could be made lighter.

Other advantages offered by such a flexible vessel include long slender structures, with the result that mechanical stresses in the skin are kept low and maneuverability is high, when towed through water. Fig. 1 shows a barge being turned around in a river. Further, when empty, such slender tubular containers could, because of their flexibility, be rolled up and returned, in a compact form, from the delivery to the supply port by conventional sea, land, or air transport, thus saving a good deal of time and/or fuel costs compared with the return of an empty oil tanker. Finally, such an oil container could, when necessary, be set up on land or moored in inland waters as a semipermanent oil store.

As shown in Fig. 2, the cross section of a floating barge with a low degree of filling with a light liquid takes the shape of a flattened ellipse but, as more and more cargo is pumped in, the cross section approaches more closely a circular shape. It was evident that, for such a long slender structure, a relatively light envelope of only moderate strength would be necessary to contain a large volume of liquid when floating in calm-water conditions, and that any additional strength requirements would be dictated by the need to meet rough water and provide puncture, tear, and wear resistance.

The effect of wave motion under sea-going conditions is to produce local bulges in the barge envelope which travel to and fro along the barge. The pressure in these bulges can be high, and adequate strength of the skin is therefore necessary to withstand these fluctuating stresses. Similar considerations apply to the fore-and-aft "sloshing" of the cargo when towing takes place through high-amplitude waves of appreciable wave length. While bulkheads would reduce this effect under pitching conditions, they would reduce the ease of rolling up empty barges and increase their cost.

[1] Assistant Director, Materials and Explosives.

[2] Numbers in brackets designate References at the end of the paper.

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"DRACONE" FLEXIBLE BARGES

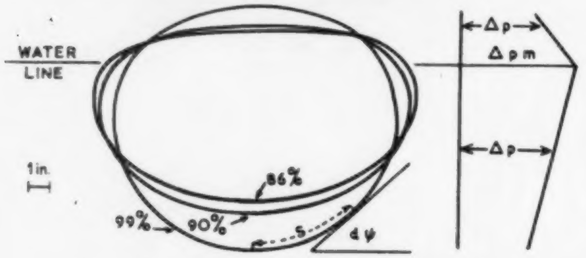

Fig. 2 This is the cross-sectional shape the flexible container adopts as it is filled with oil. The figures indicate the per cent of the container's circular cross-section area.

Towing Stability

Since the flexible vessel can bend and deform relatively easily under towing conditions, it offers the advantage in confined waters that it can more closely track the towing tug by flexing when turning sharply (Fig. 1). In one series of trials it was found that the barge could be turned around quite easily in a river of breadth equal to twice the length of the barge.

On the other hand, the nonrigidity of the vessel raises problems in stability (above certain critical speeds when towed in a straight line) such as "yawing," "bananaing," "snaking," and "porpoising," the last of which may cause severe fluctuations in drag.

It was shown [1] that a situation may arise where a small disturbance of the barge motion during towing may produce forces which tend to increase the disturbance. Such instability leads to the barge's yawing from side to side. This tendency can be initiated, for example, by cross currents flowing around the nose and tail.

While this effect also applies to rigid vessels, there are added complications with a flexible vessel. Since disturbances are met during towing at certain speeds which tend to bend a vessel, the flexible vessel can yield to these forces and take up a curved shape longitudinally. Under towing conditions such curvature favors further bending since lateral forces are set up similar to the lift an airplane gets from its curved wings. These lateral forces, set up as fluids flow past a vessel which is already bent like a banana, tend to increase the degree of bending, or bananaing. Instability initiated by a tendency to banana leads to periodic reversals of bending; that is, to snaking.

Another complication is porpoising; that is, a tendency, under certain conditions of speed and cargo, for the nose to dive and surface periodically.

The effects of speed, cargo, and geometry of nose and tail on yawing, snaking, and porpoising were studied, using a series of models of various length-to-diameter ratios, with various nose and tail shapes. These drag investigations were carried out in model ship tanks and, for the large models, in rivers and sea bays. The accurate drag measurements obtained in the ship-tank experiments on the smaller models were scaled up and checked by repeating the trials with larger models in rivers and the open sea.

Results of Tests

The conclusions [2] derived from these experiments may be summarized as follows:

Drag. The drag at any particular speed increased appreciably with decreasing cargo pressure despite the lowering of wetted-surface area (with consequent lowered

Fig. 3 Here are the general details of the 40-ton full-scale design which is being used in tests. To provide maximum flexibility, a single thickness of fabric was used, with a coating composition based on rubber.

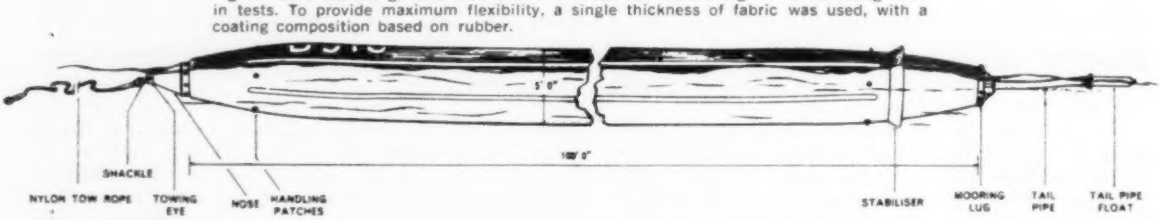

Fig. 4 The fully loaded barge under tow at high speed. Among the problems calling for solution: Yawing, "bananaing," snaking, and porpoising. The effects of speed, cargo, and geometry of nose and tail were studied.

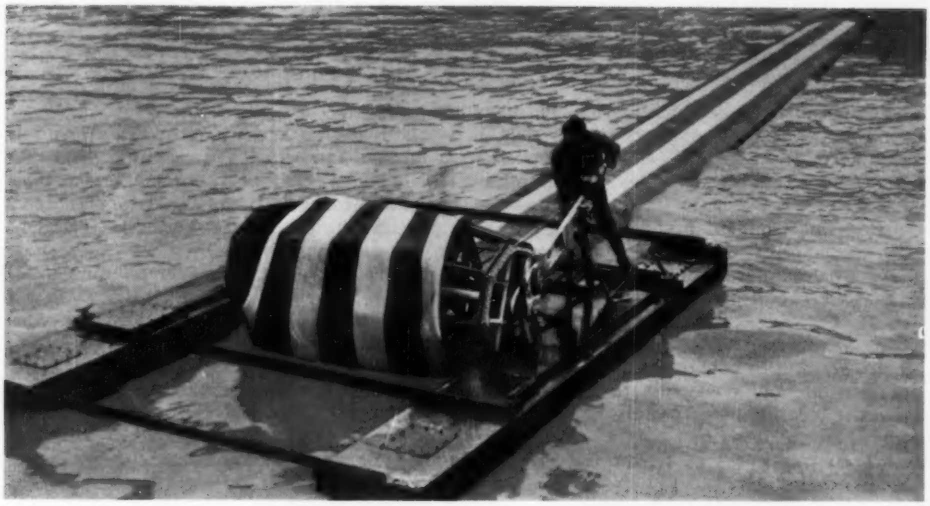

Fig. 5 Here, the empty barge is being wound on a reel. It can be returned to the supply port by conventional sea, land, or air transport, with consequent saving of time and/or fuel costs.

skin-friction drag). However, at low speeds skin friction is probably the major factor in contributing drag. Models filled with higher density cargoes, necessarily having a larger wetted surface, produced greater drag.

The results with various nose and tail shapes showed that drag is more sensitive to tail shape than to changes in nose shape. The tail shape, however, has the effect of increasing the drag if it is such as to increase barge stability—and vice versa. A blunt tail caused high form and wave drag. Similarly, it was found that the speeds at which wave-making drag is excessive are determined only by the shape of the model and are not affected by the pressure of the cargo.

Lateral Stability. Investigations of lateral stability disclosed that snaking arises from two main causes: (*a*) lack of axial symmetry of the barge caused by design or by error in manufacture, and (*b*) the ratio of diameter to length of the barge and its flexural rigidity when loaded. Barges differing in ratios or the same barge with differing density cargoes gave different degrees of stability.

In particular, snaking occurs above a critical speed normally so low (e.g., 3 knots) that steps have to be taken to stabilize the barge against snaking. This may be done by altering the flow over the stern in order to reduce or alter the lateral forces there. A sea anchor may be used for this purpose, or a boundary-layer fence at the stern (shown as a stabilizer in Fig. 3).

Porpoising. All vessels tend to develop a downward pitching movement at the nose above certain speeds. A flexible vessel yields to this tendency and under certain conditions of cargo and speed the nose, followed by the whole vessel, will dive and surface periodically. This motion is long and deep just above the critical speed at which diving begins. However, as the speed increases the diving becomes shorter and shallower. This suggests that at still higher speeds porpoising will cease and the model will move steadily on the surface.

Experiments at towing speeds which caused diving and porpoising showed that this problem becomes important with cargoes of high specific gravity; in fact, the critical speed at which diving commences varies approximately inversely as the specific gravity of the cargo.

In particular, with cargoes of specific gravity less than 0.94 there is little danger of diving occurring even at the highest operational speed of the smaller barges and, concerning the effect of nose shape and the propensity to dive, the blunter the nose the lower the speed of towing and density of the cargo at which diving commences.

Surging. The models also were used to investigate surging of the cargo in rough water and the stresses set up due to wave motion at sea. The magnitude and speed of travel of these internal fluctuations vary with degree of filling, cargo density, and so on. Because of the variation of cross-sectional area with pressure, Fig. 1, it is possible to propagate along the barge an internal pressure wave and its corresponding bulge in the envelope. In sea waves, repeated local bulges of high pressure may be seen tending to travel in the direction of the sea. As these bulges travel along the barge they in turn initiate surface waves in the surrounding water which carry the energy of the internal disturbance away from the barge. The internal fluctuations in pressure are therefore heavily damped. Experimental work has given sufficient information to enable estimates to be made of the maximum pressures likely to be encountered in service. Details of these investigations are to be published [3].

Barge Design

Based upon the results of model experiments and the data obtained, a full-scale design for a nominal 40-ton-capacity barge was completed and materials of construction selected. General details of this design are shown in Fig. 3. Fig. 4 shows a fully loaded 40-ton barge under tow at speed, and Fig. 5 an empty barge being wound up on a floating reel.

Materials for the Barge Skin. The need for the barge skin to have high mechanical strength for minimum weight and maximum flexibility pointed to a skin based on textile fabrics as the strength component. Nylon-yarn fabric was selected as possessing high tenacity and energy-to-rupture for a given weight, being chemically inert to the most likely cargoes, hydrocarbon oils, and rotproof under moist conditions—although it needs protection against the ultraviolet component of sunlight. Again, in order to provide the maximum flexibility by keeping the skin thickness to a minimum, a single thickness of fabric is preferred to a multiple or plied-skin fabric. This is also, in general, less costly. Other properties required of the fabric, which are influenced by type-of-weave and so on, are maximum tear resistance

"DRACONE" FLEXIBLE BARGES

and resistance to mechanical penetration. The weave also should contribute to good adhesion between fabric and proofing materials.

Similarly, in order to achieve the maximum flexibility of the barge wall for a given thickness, the coating compositions were based on rubber. However, in use the coating materials have many, sometimes conflicting, requirements with which to contend. The inner coating, besides being tough, possessing good adhesion to fabric, low permeability to cargo fluids, and good aging resistance must maintain these properties reasonably well when exposed to hydrocarbon-type cargoes for years.

The outer coating, besides needing to be mechanically tough, abrasion and oil resistant, and possessing high adhesion to fabric, must resist weathering and sunlight attack in all parts of the world for many years.

The various possible oil-resisting types of synthetic rubbers were considered and tabulated [4]. From these, a typical butadiene acrylonitrile-base rubber was chosen and used for the inner coating and a chloroprene type for the outer coating. The choice, in spite of certain limitations, was considerably influenced by the excellent service which both types of material have given in fuel-oil containers and petrol hoses over many years.

Barge Construction. The immediate major constructional problem to be met in making large structures from proofed fabrics arises from limitations in available fabric widths. The standard, relatively narrow, widths entail appreciable jointing or seaming.

It was concluded from tests that a lap joint using rubber adhesives would be inefficient for long service use under load in contact with petrol, and that a "mechanical" as against an adhesive or "chemical" joint would need to be developed. The obvious method to try was to bring the two fabrics in a lap joint as closely together as possible and lock them together with a standard method of sewing. Means were developed [6] for peeling back, on both faces, the cured rubber proofings along and near the edges of the proofed panels to expose the bare nylon fabric. The fabrics were overlapped and sewn to form a joint. The peeled-back proofings were resealed over the jointed fabric and given further protection by sealing an outer cover strap over the joint on both faces.

A sewn joint having a strength approaching that of the bare fabric was developed. Such joints run the full length, including the shaped nose and tail portions. Hoopwise joints are not permitted in the structure.

Finally, as will be seen from Fig. 3, the barge envelope of proofed fabric is completed with metal end fittings at nose and tail. These metal end closures involve attaching the flexible envelope to a rigid metal structure and, in order to avoid stress concentrations at the junction between the rigid and flexible members, the stiffness of the flexible component is graded over an appreciable distance in this boundary area.

The metal end fitting at the nose provides a manhole for entry for internal inspection and cleaning, means for attachment of towing lines, for venting gases, and for instrumentation connections. Similarly, the metal fitting at the tail includes attachments for connecting standard pipelines for filling and emptying.

Filling and Emptying. After the barges have been coupled to the filling pump, they are normally filled from the reeled-up position, the unreeling being kept in step with the extent of filling. Alternatively the barge can be unreeled and allowed to sink nose first and then filled, the cargo providing the buoyancy to float the barge. Similarly, for emptying, the barge can be reeled up as it empties or allowed to sink.

When empty, a barge can be transported on its reel or inflated and towed (Fig. 6).

Operational Experience

A number of 40-ton capacity barges are undergoing user trials in various parts of the world including Nigeria, Borneo, Malaya, Canada, and Norway as well as the United Kingdom. The first barge to be constructed has now completed two years of service for regular commercial deliveries of kerosene or diesel oil between the Fawley Refineries, Southampton, and Newport, Isle of Wight. Detailed inspection, both external and internal, of this barge at the end of a year's use showed that it was in good condition.

A series of additional 40-ton barges is under construction, and the construction of the first 300-ton-capacity barge (dimensions, 10-ft diam and 200-ft length) is nearing completion.

Acknowledgments

The author is indebted to Prof. W. R. Hawthorne and his colleagues at Cambridge University for helpful advice in the preparation of this paper. He is also indebted to his colleague, Mr. L. Greenwood, for certain test results, and to the Directors of Dracone Developments, Ltd., for permission to publish this paper.

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Fig. 6 Another method of return: The barge can be inflated and towed. Still another advantage: The barge could be set up on land, or moored in inland waters, as a semipermanent oil storage tank.

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Continuous Corrosion Monitoring

The "corrosion probe" makes possible the early and continuous measure of corrosion, reducing the danger of unforeseen shutdown—or failure

THE direct cost of corrosion in the United States was estimated in 1949 at $5.5 billion per year [1].[3] Since then it has increased greatly, not only because of inflation, but also because of a marked increase in the number of processes handling corrosive materials and the increased severity of process conditions. Indirect costs are also enormous.

There is a definite need for a reliable method which will not only detect but also monitor corrosion continuously and aid in the rapid selection of the most suitable construction materials. Each of the several methods used to monitor corrosion or to obtain reliable corrosion data [2] offers advantages and disadvantages.

Reliable data can be obtained by inspecting actual equipment as part of a unit shutdown. With adequate records, the inspector can determine accurately the damage that has occurred since the last inspection and can calculate corrosion rates at the points of measurement. However, inspection does not provide continuous corrosion control. Since inspections can take place only during shutdowns, there are long periods of operation when no information is available that can be related to any short highly corrosive process conditions that may have occurred. Inspection is limited in coverage, because many inaccessible locations in pipes and vessels can be examined only after destroying the equipment, and scale and deposits may interfere with measurements.

To supplement inspection data, low-cost corrosion coupons may be used. These permit many different metals to be exposed simultaneously at critical locations, and coupons with various metallographic structures and conditions are easily prepared. They can be measured accurately with micrometers or weighed to determine the total corrosion loss. However, unless special arrangements are made for a retractable device, coupons too can only be examined during shutdown and do not provide information on short-term effects. Usually coupons differ slightly from the metal used in the equipment in chemical composition, metallurgical structure, and internal-stress level—which affect corrosion resistance.

Other methods for measuring corrosion can be used during equipment operation. The oldest is the analysis of process streams for metals. If a mass balance made on a particular stream indicates an increase in dissolved metal between two locations, and if the surface area of the equipment is known, an average corrosion rate can be calculated. This method gives no indication of pitting or other types of localized attack, and analyses may be affected by scale or fluctuations in the detergent action of the effluent stream. Taken over a long period of time, metal analyses can be used to monitor corrosion.

Newer methods of monitoring corrosion of actual equipment are based on reflection and resonance techniques that utilize ultrasonic waves [3], absorption techniques by x ray or gamma ray [4], and a gamma-ray backscatter technique (Penetron). These are highly specialized methods that require careful interpretation and have an accuracy of 2 to 5 per cent of the metal thickness. Although they can indicate internal flaws in the metal, such as those caused by hydrogen fissuring or by stress-corrosion cracking, they do not indicate surface pitting.

The corrosion probe, the most sensitive method for detecting and measuring corrosion, can measure losses as small as a few millionths of an inch. Such accuracy permits rapid determination of corrosion rates. Probes can be installed at any point in a unit, and measurements can be made without interfering with the normal operation of the unit. Thus continuous monitoring is possible. Because of the high sensitivity, the effects of small changes in operating conditions can be evaluated, and corrosion-prevention methods can be devised and tested while the unit is still on stream.

Probes are extremely useful tools for determining corrosion mechanisms. Corrosion can remain constant with exposure time, decrease with time, increase with time, or combine all three effects. Because probes permit continuous monitoring, the effects of time can be evaluated readily. The corrosion mechanism is important when short-term tests are extrapolated to a yearly basis.

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[3] Numbers in brackets designate References at end of paper.

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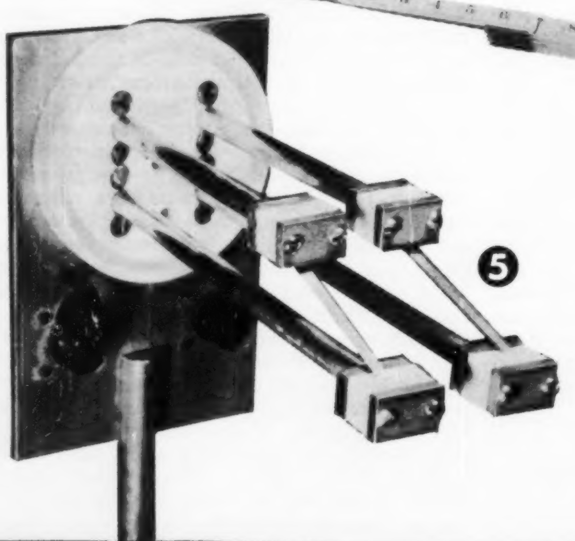
Continuous Corrosion Monitoring



Types of Corrosion Probes

The test specimen in commercial corrosion probes may be either a wire, a strip, or a thin wall small-diameter tubing with a specimen thickness of 0.001 to 0.080 in. (1 to 80 mils). The type to use depends upon the conditions of use.

Fig. 1 A simple dip-type probe can be used for open systems at asmospheric pressure

Fig. 2 The upper plug-type probe is suitable up to 200 F and 500 psi, the lower one to 400 F and 1000 psi

Fig. 3 A flanged probe can be used wherever screwed fittings are not considered suitable, or outside temperature of the vessel or line wall exceeds 400 F. It is commercially available rated at 1000 F and 1000 psi.

Fig. 4 The retractable probe can be inserted or removed while a vessel is on stream

Fig. 5 The laboratory-type corrosion probe permits replacement of test specimens and is suitable for low-cost multiple tests

Probes only indicate general surface corrosion. Other types, such as pitting, stress-corrosion cracking, crevice corrosion, hydrogen penetration, or intergranular attack can be evaluated only after the probes are removed for examination. Like coupons, probes also suffer the disadvantage that they are not made of the exact metal used in the equipment.

The number of corrosion probes used in the refining industry has rapidly increased since they became available in 1957, and several thousand are now in use.

Principle of Probe Operation

The principle of corrosion probes has been discussed in earlier publications [5, 6, 7]. Briefly, the electrical resistance of a metal or alloy depends on its cross-sectional area. Thus, when a metal specimen is exposed to a corrosive medium, the change in resistance of the specimen can be related to the corrosion loss.

The electrical conductivity of metal corrosion products, except some high-purity sulfides formed in clean sulfidic systems, is negligible compared with the conductivity of the metal specimens. Therefore corrosion products need not be removed, and the electrical measurements can be made with the probe in place in operating plant equipment.

Changes in specimen temperature will also change the voltage drop. However, temperature corrections can be made by simple calculations or by using temperature-compensating "reference" resistances within the circuit.

Because the resolution achieved in comparing electrical resistances is very high, small amounts of corrosion can be detected and measured quantitatively. Resolutions on the order of 1 or 2 microin. are commonplace, and a rate of 0.005 in. per yr (ipy) can be detected from measurements taken only a few hours apart.

Different electrical circuits may be used to measure the resistance changes. Some of these circuits are calibrated to read directly in microin. of corrosion and are available as commercial instruments.

Types of Corrosion Probes

The test specimen in commercial corrosion probes may be either a wire, a strip, or a thin-wall small-diameter tubing. The specimen thickness usually is 0.001 to 0.080 in. (1 to 80 mils). The type of probe to use depends upon the conditions of use.

For open systems at atmospheric pressure and moderate temperatures, a simple dip-type probe, Fig. 1, can be used. The probe is suspended in the open vessel, and the attached electrical cable is run to a convenient location for corrosion measurements.

For closed systems, three types of probes can be used—plug, flanged, or retractable. The upper plug-type probe in Fig. 2 is suitable for temperatures up to 200 F and for pressures up to 500 psi; the lower plug-type probe is suitable up to 400 F and 1000 psi. A flanged probe, Fig. 3, can be used wherever screwed fittings are not considered suitable, or where the outside temperature of the vessel or line wall exceeds 400 F. The commercially available flanged probe is rated at 1000 F and 1000 psi. The main advantage of the retractable probe, Fig. 4, is that it can be inserted or removed from a vessel while it is on stream. This feature probably accounts for its popularity in petroleum refineries [8]. The probe is inserted or removed through an appropriate full-opening gate valve below 400 F and 500 psi, although insertion by hand is generally impractical above 150 psi.

Fig. 6 A portable commercial corrosion meter is battery operated and supplied with meter-to-probe connecting cables from 6 to 250 ft long.

For laboratory testing, a simple probe of the type shown in Fig. 5 can be used. The test specimens can be replaced and, thus, the probe is suitable for low-cost, multiple corrosion testing. Many variations of this type of probe can be fabricated readily for use with standard or special laboratory equipment.

A portable commercial corrosion meter, Fig. 6, that is simple to operate, can be used safely wherever any battery-operated instrument can be used. Meter-to-probe connecting cables 6 to 250 ft long are in common use.

Probe Applications

Continuous monitoring with corrosion probes has been applied to a wide variety of corrosion problems ranging from the selection of construction materials for a pilot plant to the subsequent evaluation of process corrosivity in the commercial unit.

Evaluation of Materials of Construction. From a few laboratory tests, the types of alloys required in the construction of pilot-plant equipment can be determined readily. Typical corrosion information that can be gathered in laboratory screening tests is shown in Fig. 7. The data were obtained from a single corrosion test in an organic-acid solution containing process impurities.

Carbon steel would be totally unsuitable for use in this service. Even Type-304 stainless steel appears inadequate. Type-316 stainless steel looks promising with corrosion apparently decreasing to a negligible value after about 20 hr. This could be caused by protective-film formation or by depletion of the corrosive agent in the solution. In an actual process this may not be realized if high velocity exists or depletion effects are negligible. Hastelloy C could be relied on for excellent corrosion protection if subsequent work proved Type-316 stainless steel to be unsuitable.

In this example, data obtained with corrosion probes indicated in a short time what class of alloys could be considered for the application and indicated relative corrosion rates. Of course, the ultimate choice can be made only after all factors that might influence corrosion have been evaluated.

Evaluation of Corrosivity of New Processes. The effect of the temperature of distillation residues on the corrosion rate of Type-316 stainless steel was determined with labora-

tory-type corrosion probes, Fig. 8. In a short time, probe data showed that the steel probably would be a suitable construction material up to about 350 F. In this temperature range, the protective oxide films on the surface of the steel appeared to be maintained. At higher temperatures, the films broke down, and accelerated corrosion occurred.

Corrosion Monitoring at Critical Locations in New Unit. The data obtained by four probes monitoring corrosion over a period of about three years in the overhead stream from a crude-oil-distillation unit are shown in Fig. 9. When desalting was poor, corrosion rates were high despite the use of ammonia for pH control and about 10 ppm of a commercial corrosion inhibitor. When the desalter operated satisfactorily, corrosion became negligible, as shown by the horizontal portions of the curve for Probe 3. After the corrosion inhibitor was changed, Probe 4 indicated a corrosion rate that increased parabolically. This type of curve may indicate either a real increase in general corrosion or pitting. In this case, the probe was removed for laboratory evaluation, and pitting attack was found to be the cause.

About this time, the unit was shut down and the overhead condensers were inspected and calipered for the first time in three years. A total thickness loss of 0.12 in. was measured, and some pitting was detected. The caliper measurements gave an average corrosion rate of 0.04 in. per yr (ipy), whereas the probes had shown rates ranging from negligible to 0.12 ipy. On the basis of the probe readings, correlations between corrosion and operating conditions could be made, and the necessary steps taken to control corrosion. This action could not have been taken on the basis of a single inspection.

Evaluation of the Effects of Operating Changes on Corrosion. Corrosion probes with mild-steel specimens were installed immediately after the primary and secondary condensers of the atmospheric tower of a pipestill running crude oil that contained 0.4 per cent sulfur. The crude oil was desalted before being fed to the tower, and both a corrosion inhibitor and ammonia were added to the overhead stream upstream of the primary condenser.

During the first few days of operation, inhibitor and ammonia were not injected. As a result, the probe after the secondary condenser indicated an initial high corrosion rate of 0.27 ipy, Fig. 10, which decreased markedly a few hours after injection was begun. However, during the next 40 days, the operating efficiency of the desalter was erratic and corrosion rates varied widely. The probe reacted so fast to a change in the salt content of the crude oil that sometimes the people reading the probe were aware of poor desalting before the operating people were. When the desalting conditions were brought under control, essentially no corrosion was detected for about two weeks.

At that time, a three-day trial was made to evaluate a low-pH method of operating crude stills [9]. At a pH of 5.2, a corrosion rate of 0.94 ipy was indicated by the probe in the secondary condenser (0.15 ipy in the primary condenser), despite continued inhibitor injection. Apparently, the charge to this particular unit was too high in sulfur and salt content—even after desalting—to permit satisfactory operation at low pH.

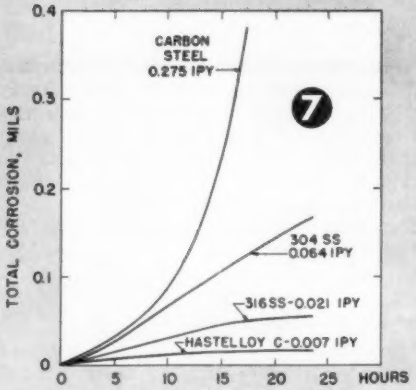
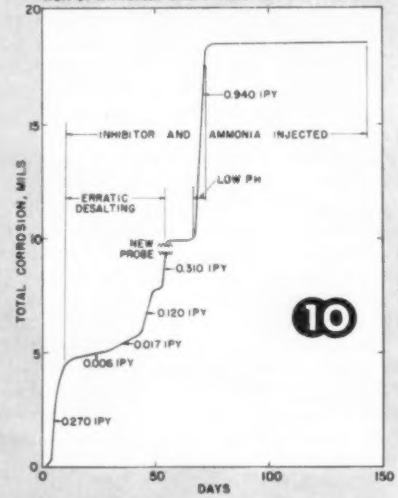


Fig. 7 Evaluation of construction materials at 104 F from a single test

Fig. 10 Effect of operating changes—injection of inhibitor and ammonia—on corrosion



Evaluation of Stream Composition. A probe with a specimen containing 5 per cent Cr and $^1/_2$ per cent Mo was installed in the 750-F inlet line to the furnace of a catalytic-cracking unit to determine the effects of the sulfur content of a gas oil on corrosion. As shown in Fig. 11, the corrosion rate decreased during four days of operation with low-sulfur oil but increased when high-sulfur oil was reintroduced on the ninth day. As expected, the probe showed that a reduction in sulfur content of the gas oil reduced corrosion. Nevertheless, the low-sulfur gas oil contained too much sulfur to be processed in 5 per cent Cr $^1/_2$ per cent Mo alloy lines. In about two weeks, the test showed that either the sulfur content must be reduced or a more resistant alloy must be used to obtain adequate corrosion resistance in this service.

Evaluation of Corrosion Inhibitors. One of the most important applications of probes is in evaluating alternative corrosion-protection measures. For example, a probe was used to evaluate a series of three commercially available corrosion inhibitors in a light-naphtha condenser after a short period with no inhibitor, Fig. 12. The corrosion rate dropped from 0.25 ipy with no inhibitor to 0.02 ipy with Inhibitor I and 11 ppm. When the dosage was increased to 22 ppm, the corrosion rate decreased to 0.01

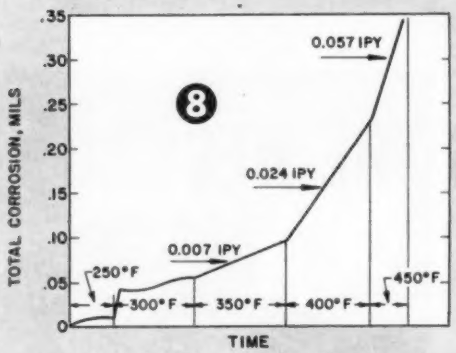


Fig. 8 The effect of temperature on corrosion rate of Type 316 in distillation residues

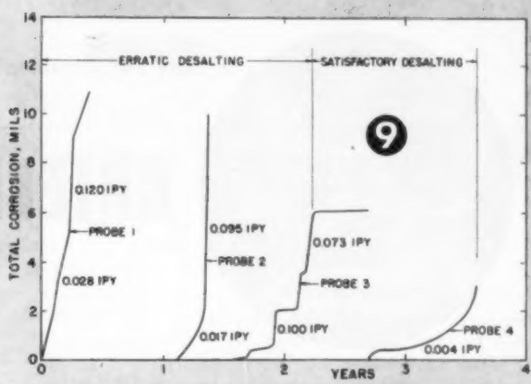


Fig. 9 Four probes monitored corrosion for about 3 yr in the overhead stream of a new crude-oil-distillation unit

Fig. 11 Evaluating the effects of changes in the sulfur content of the process-stream composition

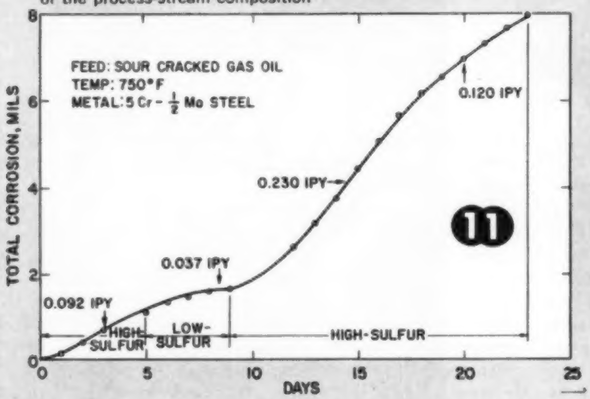


Fig. 12 The differences in effectiveness of corrosion inhibitors at varying ppm

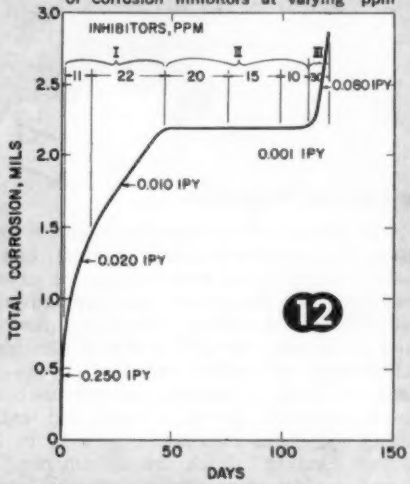


Table 1 Installation Costs for Corrosion Probes

	Plug-type	Flanged	Retractable
Probe	\$101.00	\$250.00	\$132.00
Nozzle	10.00	100.00	50.00
Labor	59.00	150.00	108.00
Total	\$170.00	\$500.00	\$290.00

ipy. Immediately after changing to Inhibitor II, the corrosion rate dropped to zero. When Inhibitor III was introduced, the rate immediately increased to 0.08 ipy.

This not only gave a quantitative comparison of corrosion rates with inhibitor concentrations but showed the striking changes in corrosion rate that can occur when one inhibitor is substituted for another during normal operations.

Conclusion

The penalty of unforeseen shutdown or failure in the single large processing units, operating at higher temperatures and pressures than the multistage units and batteries of small units which they are replacing, is high.

When the costs for installing corrosion probes, Table 1, are compared with the potential saving for preventing just one scheduled shutdown, the use of the probe is obviously low-cost insurance. The extreme utility, low cost, and ease of operation of corrosion probes have led to the recognition and use accorded other standard instruments such as the thermocouple and pressure gage.

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Abstracts and Comments Based on Current Periodicals and Events

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Associate Editor

BRIEFING THE RECORD

Special railroad car for piggyback trailer hauling has unique "skeleton" design. All parts formerly needed to provide a loading and unloading path for the trailer are eliminated. The car is designed to carry trailers that vary in length from 35 to 40 ft.

Side-Loading Piggyback

AT THE request of the Canadian Pacific Railway, engineers of General Motors Diesel Limited, London, Ont., Canada, have designed and developed a new system of side-loading for piggyback rail operations based on specific CPR requirements. Because of low population density in Canada, the CPR is one of the largest piggyback operators in North America.

Loading highway trailers onto flatcars with most methods requires a system of ramps and walkways and breaking the trains into modules of 10 to 15 cars for sequential loading. With this system piggybacks ride high and, in addition to vertical and lateral accelerations, there is increased wind resistance. Unnecessary weight and beam strength are also built into standard flatcars.

A basic design for handling standard 35 to 40-ft-long highway trailers developed by GM is described in an article by Harvey E. Martin in the April-May-June, 1961, issue of the *General Motors Engineering Journal*. Highway trailers would be side-loaded minus their rear wheels, permitting loading from either side with a vehicle resembling a fork-lift truck.

The two prototype railway cars that were built were named GM Portagers. Their design is much simpler than that of the ordinary flatcar. Because the maximum load of 60,000 lb of a highway trailer is within the capacity of four 33-in-diam wheels, two-wheeled trucks were used in a "skeleton" design. The vertical load is supported directly above the trucks on an open steel frame at each end of the rail car. A 16-in-diam single tubular center sill connects the trucks and provides routing for the air-brake piping. The sill provides high buff and drag strength and relatively low torsional resistance to assist in the track-holding ability of the car. Rubber draft gears with standard Type E couplers are provided at each end of the center sill.

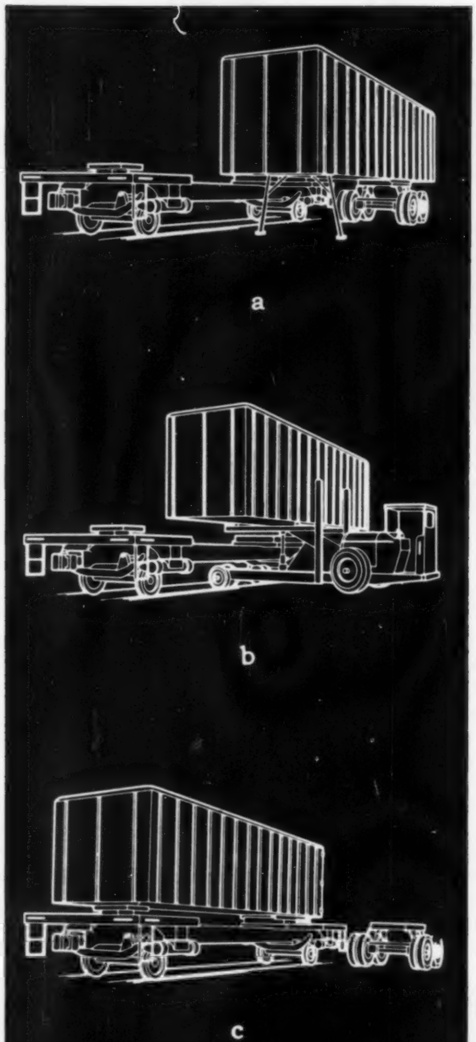
To develop a high degree of roll stability, trucks are attached to the underframe with a four-point swing link.

The four-point swing links are connected to the arms of torsion springs mounted on the underframe, providing torsion resistance through two preloaded rubber bushings. These also act as structural members and to give a degree of vertical impact damping.

Support for the trailer duplicates the manner in which it would be carried in highway service. The support is provided at the rear of the Portager by rails having the same spacing as tractor-tandem (rear-wheel) support rails. At the front of the Portager, a highway-tractor king-pin hitch, or fifth wheel, is used. This hitch is connected to the underframe through a dual, high-capacity rubber-element arrestor gear. This gear allows up to 10 in. of restrained movement of the trailer fore and aft from the centerline of the hitch. This movement cushions the container and its load from railroad impacts. Frictional forces at the arrestor gear and rear rails add damping capacity and prevent continual fore-and-aft jostling of the trailer while in transit.

Less horsepower will be required to pull the Portager piggyback train because the average loaded weight is reduced by approximately 20 per cent, the lower profile provides less wind resistance, and there are half as many wheels and bearings. Reductions in loading and unloading man-hours of over 50 per cent, as compared with "circus loading," have already been demonstrated and a potential exists for further development in this area. Potential savings also exist in the areas of rolling stock investment, trailer tandem investment, maintenance (due to fewer parts), stable high-speed-tracking, soft-riding, and impact-protection features.

New Portager, **left**, offers less wind resistance and less dead weight than conventional piggyback carrier, **right**. Lower profile brings over-all height within all railroad system clearances giving a favorable center of gravity.



Shown here are three sequential positions of the piggyback system equipment during a loading operation. In **a**, the highway trailer together with its rear wheels, or tandem is parked and is ready to be side-loaded onto the rail car. In **b**, the loader has maneuvered into position under the trailer, lifted it off its rear tandem, and is in transit with the load toward the rail car. In **c**, the trailer has been positioned and lowered onto the rail car. The king pin hitch of the rail car is secured to the king pin of the trailer. Unloading is accomplished by a similar procedure in reverse sequence.

Packaged Gas-Turbine Plant

A 12,000-kw Econo-Pac gas-turbine power plant has been purchased by the City of Houma, La., from the Westington Electric Corporation's steam division. The new self-contained automatically controlled unit was sold on a "turnkey" basis, which includes installation.

The complete "package" will be semiportable, with prefabricated construction, and it will be used primarily for low-use-factor peaking service of about 1000 hr per yr. The unit is capable of continuous service if required.

Houma, a city of about 27,000 population located in the heart of the "gas country" southeast of New Orleans, will provide fuel for the new plant from its own wells. However, automatic transfer to distillate-oil fuel is provided in the event of failure of the gas system with no disruption in power production.

The Econo-Pac line was developed to meet a need for gas-turbine power plants in small "packages"—3000, 7000, and 12,000-kw rating. They provide a quiet unattended power source at minimum capital investment. The new units supplement the company's 22,000 and 44,000-kw gas-turbine power plants.

The entire Econo-Pac plant requires only a flat concrete-slab foundation approximately 3 ft thick, plus electrical and fuel connections. This means that a unit can be in operation less than two weeks after delivery to the site.

The complete installed cost of Econo-Pac plants is claimed to be considerably less than the first cost of a conventional generating plant in this size range.

Evaporative inlet air coolers can be used to maintain full generating capacity when the dry-bulb air temperature exceeds 80 F. When ambient temperature is 40 F and below, the output of an Econo-Pac plant is 25 per cent in excess of its 80-F rating.

"Turnover" Conveyer Belt

A "turnover" conveyer belt that automatically twists itself, reversing top and bottom surfaces of the belt, is in use at the Ohio Power Company's Muskingum River Plant, near Beverly, Ohio.

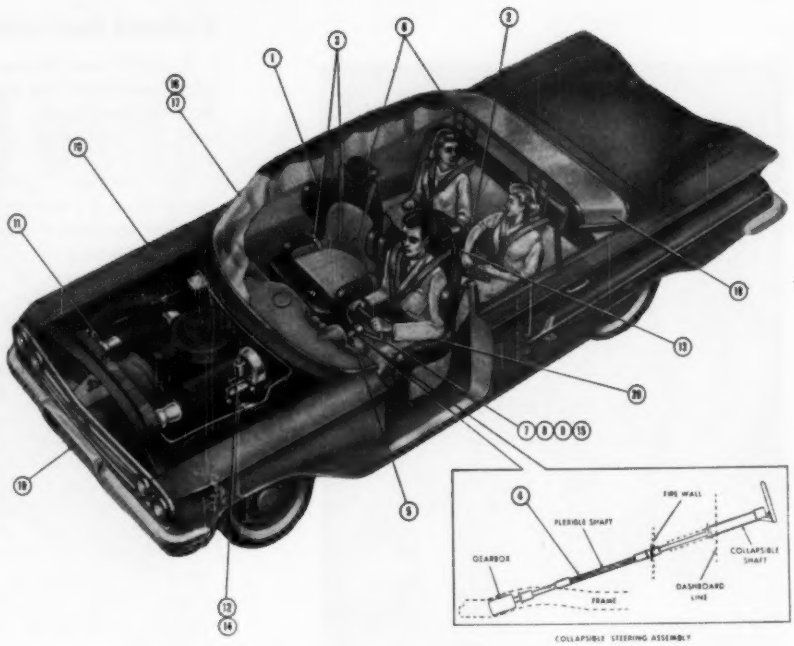
It is one of 14 flights of belting used in a conveyer system that has hauled more than 13 million tons of coal since it went into service in 1953. The system transports 800 tons per hr over a $4\frac{1}{2}$-mile uphill down-dale course from a strip mine to the coal-storage area on the river bank.

The turnover prevents build-up of sticky materials on idlers or pulleys avoiding clogging and damage to both belts and idler equipment.

To keep its clean side on top of the return idlers, the 4480-ft belt delivers its load, then makes a 180-deg twist to present a clean face to the idlers, turns to the loading point, and makes another 180-deg twist before accepting the new load. The belt's thick carrying cover is always positioned to receive the load.

The turnover system can be applied to any conventional conveyer system placing two twist pulleys at each end of the belt flight and without altering the conveyer framework. It is recommended for use wherever moist, wet, or sticky materials such as coal, iron ore, shale, or wet sand are handled. Wet material can be handled at low temperatures with no danger of the belt freezing to pulleys and idlers.

Features of Survival Car II: **1** Capsule chairs; **2** protection for rear passengers; **3** seat belts and shoulder harness; **4** flexible stearing shaft; **5** telescoping steering tube; **6** whiplash protection; **7** small, rectangular steering wheel (to prevent injury to kneecaps); **8** small wheel gives greater visibility; **9** small wheel gives greater maneuverability; **10** unit body construction with high energy adsorption; **11** automatic fire-control system; **12** safety brakes (braking retained on two wheels if a line fails); **13** roll bars; **14** power brakes; **15** power steering; **16** safety windshield with double-weight filler (greater resistance to penetration); **17** Saflex interlayer to cut out ultraviolet rays; **18** tinted glass to reduce heat load; **19** reflective license plates for greater visibility; **20** support of arms to reduce driver fatigue.



Survival Car II

An engineer for the Liberty Mutual Insurance Company has redesigned a stock car, incorporating features to enable occupants to survive an accident—even a fairly hideous accident. (For Survival Car I, see Mechanical Engineering, Dec., 1957, pp. 1150–1151.)

Survival Car II, engineered by Frank J. Crandell, contains 24 features to prevent or minimize injuries. They range from wrap-around seats, giving protection against side impacts and capable of withstanding 30-*g* crashes from any direction, to a flexible section of steering shaft (comprised of piano wires woven in such a way as to transmit the torque of steering, yet buckle under axial impact). The "collapsible" steering column, which eliminates the most deadly source of injuries to drivers, also necessitates a small, rectangular "wheel," to prevent smashing of kneecaps.

The car is based on a standard 4-door sedan, giving the "roll-bar" protection of center posts. Additional roll-bar effect is incorporated in the backs of the bucket-type front seats, along with a head rest to prevent whiplash injuries (in rear-end collisions). Webbing braces the heads of rear-seat passengers against whiplash. It almost goes without saying that passengers are equipped with seat belts and shoulder harness. Unless something comes in and hits them, occupants will stay in their seats, their necks unbroken.

Shock to passengers is minimized by unit-body construction with high energy-absorption factor so that the structure absorbs shock. In a severe impact, the car will be ruined, but you'll walk away from it. An automatic fire-control system is installed under the hood. A safety-brake device automatically cuts off front or rear hydraulic lines, should one line fail, maintaining two-wheel brake action.

An "Alert-O-Matic" signal system keeps the driver from dozing on long trips. Turn on this system, and a red light begins flashing on the dash, once a minute. You must turn off this red light by touching the horn ring. If you don't, the horn will blow. If you still don't react, the ignition will be cut off.

Besides "packaging the passenger" like fragile merchandise and providing many features to reduce fatigue, the car has a smooth hood designed to minimize wear and tear on pedestrians who may be hit.

"The ultimate aim of this program," Crandell stated, "would be the reduction of automobile premiums paid by policy holders through the elimination of the prime causes of injury."

Liberty Mutual Insurance Company hopes that the safety features demonstrated in this car will win public response and will be adopted by Detroit for the standard product.

Another Engineering Shortage

In no time at all, industry is going to be hobbled by another severe shortage of engineers—and it is doing little to cut the inevitable effects.

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Few businessmen, in fact, are even aware of the fast-approaching crisis, the article continues.

"Industry appears to be pretty unintelligent about it," says Howard Meyerhoff, executive secretary of the Scientific Manpower Commission. He is backed up by another expert, Sydney B. Ingram, chairman of the Engineering Manpower Commission of Engineers Joint Council.

All companies won't be hit equally hard by the shortage. "We're not having any trouble hiring all the engineers we need, and we don't expect any problem in the future," says The Martin Company's Albert C. Hall, Mem. ASME, vice-president for engineering. Hall concedes that his company's glamorous products—mis-

iles and satellites—are the explanation. Less fortunates are manufacturers of such products as cranes, trains, and kitchen sinks.

The percentage of freshmen entering engineering colleges has dropped sharply in the past three years, and even if the trend reversed suddenly it would take four or five years before there would be much effect.

In the meanwhile, the inexorable progress of technology—and the scientific prowess of the Russians—are creating new and more complicated jobs for engineers.

Among the warning signs are the fact that right now industry is having a hard time filling jobs in many technical specialties and that beginning engineering salaries are still climbing, though not so fast as in recent years.

Says President Leo A. Weiss, of Avien, Inc.: "We are having no trouble at all hiring warm bodies. But we're moving heaven and earth to find that rare talent we need so desperately."

Genesis of the current calm-before-the-storm goes back to 1957 and 1958 when many companies laid off engineers and technical people as a recession measure. The effect of the widespread publicity on the end of the engineering shortage on engineering enrollments was immediate.

"Industry will pay the piper in sharply reduced numbers of engineering graduates in 1961, '62, and '63," says Carl Frey, executive secretary of the Engineering Manpower Commission.

Another by-product of the mass firings: a swelling of the ranks of what one chief engineer calls "the chronic malcontents—those temperamental engineers, or one-time C-minus students, who are constantly writing letters to technical journals complaining that there is a surplus of engineers—because nobody wants to pay $15,000 a year for their dated talents."

Today, engineering's shrinking prestige when compared to "science," the new glamour profession, is another sore point. Industry, urges Dr. Ingram, should raise engineers' status. "Company presidents blow up every advance into a 'scientific breakthrough.' Yet nearly all these innovations are really high-class engineering, and that's what they should be called."

How can industry gird for the coming shortage? First, to beat off personnel pirates, the company that wants to hang on to its engineering staff will have to take precautions. "Salaries must be competitive," says Avien's Weiss. "I don't believe all these surveys that report money takes second place to 'challenging work,' etc. That may be what the engineers tell the interviewers, but that's not how they act. You have to meet or beat your competitor's offer."

"Autonomy" is what engineers look for, thinks Van M. Evans of Deutsch & Shea, Inc. "You have to give them a certain amount of freedom, responsibility, and professional status, or they'll go somewhere else to get them."

Relieving them of routine work is another way to keep the engineers contented—and make the best use of their talents. One recommendation: turning over more routine design work to computers.

There's not much hope of going far on another recommendation: hiring more technicians to do low-level tasks now assigned to engineers. The shortage of technicians will soon be just as acute as that of engineers.

President Henry M. Blackstone of Servo Corporation of America offers one solution to the shortage of technicians. He says there are plenty of automatic plotting and recording instruments available to replace technicians who now watch tests for hours on end.

Certain types of engineers will be even more in demand than others in the coming general shortage, and companies that encourage their engineers to bone up on the latest technologies and take in engineering conventions and seminars will have an easier time of it. When the need for some new specialty arises, it will be less traumatic for some present staff member to take charge.

3-D Radar

A PROGRESSIVE three-dimensional picture of the trails of aircraft under surveillance is presented by an operating radar announced by Hughes Aircraft Company's ground systems group, Fullerton, Calif.

Called 3-D Frescan radar, it has a Stereoscan display which provides depth perception, enabling the viewer to distinguish altitude separation between target trails as well as their range and bearing.

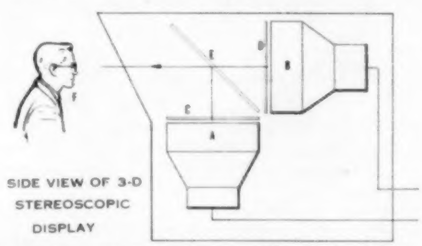
This radar is being used on Navy ships and is similar to the company's Frescanar 3-D system now deployed by the Army with Missile Monitor in Europe.

The electronic advance achieved by combining Stereoscan with 3-D radar promises to solve many of the vexing problems encountered in air-traffic control and surveillance.

Operators wearing simple polarized glasses are able to distinguish differences in altitude between merging targets which, in a flat or two-dimensional display, would appear to be approaching collision.

Now an observer is, in effect, able to view in three dimensions a scaled-down portion of the earth's surface in his region, including the air space above it and everything within that space.

Stereoscan 3-D radar display is achieved by using a half-silvered mirror E which combines the images from storage display tubes A and B polarized by the filters C and D. Observer wears polarized glasses. In the lower photo, the display is at left, and the special 3-D Frescan antenna is at the right.



"Plowshare" Analysis

Eight blasts set off at different depths in volcanic rock at the Nevada Test Site have been studied under Project Plowshare—the three-year-old probe of the peaceful use of nuclear explosives (Mechanical Engineering, January, 1960, p. 36; November, 1960, pp. 86–87). Unfortunately, the prediction of the behavior of nuclear explosives in other types of rock than volcanic tuff is still uncertain.

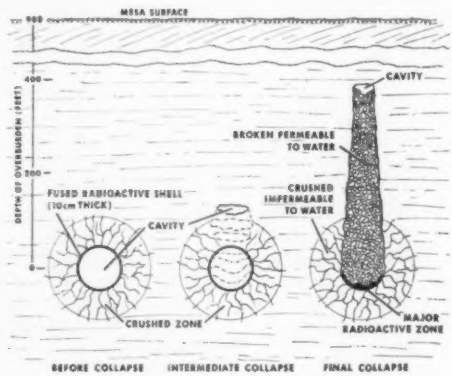
William T. Reid, Mem. ASME, Assistant Technical Director, Battelle Memorial Institute, Columbus, Ohio, describes some of the results of these studies in an article in the March, 1961, *Battelle Technical Review*.

The depth at which a nuclear explosive is fired, and its yield, controls the manner in which earth movement occurs. A measure of this depth, which allows for the size of the explosion, is the "scaled depth," determined by dividing the depth in feet where the explosion occurs by the cube root of the yield in kilotons. Where the scaled depth is 20 ft or less, the material excavated is pulverized to dust and is almost entirely blown out of the crater. At a scaled depth of 65 ft there is an open crater and extensive crushing of the rock beneath the site of the explosion. Maximum crater volume occurs at a scaled depth of about 150 ft. Beyond a scaled depth of 300 ft, no open crater is formed, and all the energy of the explosion is utilized in producing an underground cavity, crushing the rock about it, and raising the temperature of the surroundings.

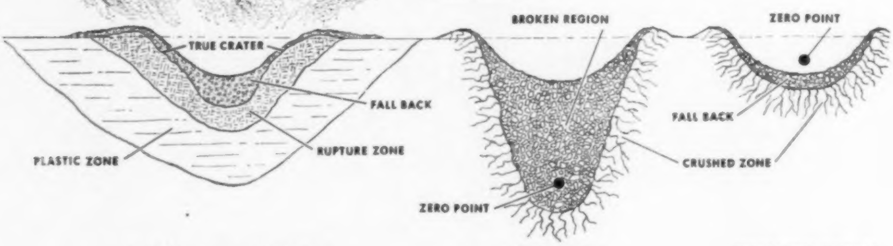
Thus, for earth moving, explosions at a scaled depth of about 150 ft will produce the largest crater.

In the case of the Rainier experiment, where the scaled depth was 670 ft, there was no break-through of the explosion at the surface. A cavity, 130 ft in radius, was formed around the detonation point, lined with 4 in. of melted rock. Within a few seconds, the roof of this cavity collapsed by successive caving upward for about 400 ft leaving a large cylindrical shaft above the detonation point filled with crushed rock. In this experiment, where the yield was 1.7 kilotons, the explosion crushed an estimated 500,000 tons of rock and the caving pro-

Left to right, the sequence of actions around the point of detonation of a nuclear device



The left profile shows the principal zones of a typical crater as created by a nuclear device. **Other profiles** show the effect of depth of burial of devices on crater formation.



TYPICAL CRATER PROFILE DEEP BURIAL SHALLOW BURIAL

Comparison of Energy Costs

	Nuclear devices					Conventional fuels		
	10 kt	100 kt	1000 kt	10,000 kt	100,000 kt	Coal[b]	Oil[c]	Gas[d]
Charge for nuclear explosive[a]	$500,000	$750,000	$1,000,000	$1,100,000	$1,200,000	...	...	...
Typical unit cost for fuels	...	...	...	...	...	$6.50 per ton	$2.50 per bbl	$0.25 per 1000 cu ft
Cost per therm[e]	$2.50	$0.38	$0.05	$0.0055	$0.0005	$0.028	$0.046	$0.028

[a] Includes charges for the device, placing it in position, making attachments, firing, and safety provision. Does not include site preparations or construction activities.
[b] Pennsylvania.
[c] New York.
[d] Texas.
[e] 100,000 Btu; 50 per cent recovery assumed for nuclear devices, 90 per cent recovery for fuels.

duced 200,000 tons of permeable rock. On this basis for Nevada tuff, crushed rock impermeable to water amounted to 300,000 tons per kiloton yield, and rock broken by caving added 120,000 tons per kiloton yield.

About half the total energy released, or more than 3 billion Btu, was available above 400 F at the time bore holes were sunk to measure temperature. The highest temperature observed 18 months later was 194 F.

Nuclear explosives are unique compared with chemical explosives. They release larger quantities of energy than is feasible with chemical explosives and they release this energy a thousand times more rapidly than the fastest chemical detonations. Their most important characteristics for peacetime purposes are the heat released and the explosive work they can perform.

Heat from small nuclear devices is expensive, 50 to 100 times more than that from conventional fuels. Even with thermonuclear devices in the 1-megaton range, the cost of energy is still about twice that from coal or natural gas. Still larger nuclear devices would cost little more, and so multimegaton thermonuclear explosives might compete costwise with conventional sources of heat if they could be used effectively.

Hence it must be concluded that heat produced from nuclear explosions in anything except the larger sizes cannot compete economically with existing conventional processes. Costs of nuclear explosives would have to be reduced by a factor of 50 to 100 in the 10-kiloton range and by two in the megaton range to become competitive, assuming the correctness of quoted prices.

Nuclear explosives provide an effective means of moving and breaking large quantities of earth and rock. Equivalent in explosive power to from 50 tons to a few million tons of conventional explosives, nuclear devices are compact, being packaged in a case from 7 to 14 ft long and 30 to 36 in. in diam. This small size permits nuclear explosives to be placed in position more easily and at less cost than equally effective chemical explosives. Although chemical explosions of more than 500 tons have been fired, such huge blasts have been rare.

Even the cheapest of the commercial explosives costs nearly three times as much as the most expensive nuclear explosive. Comparing a megaton thermonuclear device with TNT shows that the yield per dollar is 400 times greater for the thermonuclear explosive.

However, nuclear devices are less efficient blasting materials than chemical explosives, with the result that the heat of explosion is utilized less effectively. While only 1 lb of conventional explosive is required to excavate 1 cu yd of rock, or about 2 million cu yd per kiloton, nuclear devices excavate from 100,000 to 300,000 cu yd per kiloton. This fact changes the economic situation, and it is found that nuclear explosives are cheaper only for the large explosions. The cost of the explosive alone is 2¢ per cu yd for a 1-megaton device, compared with 20¢ per cu yd for conventional explosives. Larger explosions would give even cheaper blasting. Smaller nuclear explosions cost more than chemical explosions, per cu yd excavated.

On this basis, where large explosions are required or can be tolerated, nuclear explosives are cheaper than chemical explosives.

In general, the problem of transferring radioactivity from a deeply buried explosion to underground water supplies is not considered serious, but the problem has not yet been entirely evaluated.

Because of their effectiveness in excavating, nuclear explosives have been suggested in a test known as Project Chariot for producing a harbor on the Alaskan coast at Cape Thompson, 350 miles above the Arctic Circle.[1] A harbor in this location would facilitate exploitation of Alaska's reserves of coal and oil. It was proposed initially that five nuclear devices be exploded simultaneously, three 20-kiloton explosions to provide an entrance channel, and two 200-kiloton explosions to form the main turning basin. Later plans call for only four nuclear devices in this experiment. At a scaled depth of 260 ft, most of the excavated permafrost soil would be thrown free of the craters, and from 5 to 20 per cent of the radioactivity would be released. The isolated location of the experiment would minimize problems of fall-out.

Because there are many areas in the world where potable water is in short supply, nuclear explosions have been considered for supplying the heat needed for distillation processes, or for producing underground aquifers where water could be stored. Heat from nuclear explosions is too costly for distillation except for very large nuclear devices, particularly in view of the high thermal efficiency now obtained by distillation plants using conventional energy sources.

Underground storage basins produced by deeply buried nuclear explosions may have more merit, but their potentialities cannot be estimated until more data are available on the characteristics of such explosions in different types of underground structures, and on the extent of radioactive contamination.

The Plowshare studies are in a preliminary stage. Suggested uses are speculative, and it is too early to make adequate evaluations of the ultimate uses for which nuclear explosives might be practical. Many tests would need to be made before the capabilities and the limitations of these devices can be stated.

[1] The possibility of using nuclear explosives to excavate a second Panama Canal has recently been in the news. The author states that: "As visualized, this would require the firing of 651 nuclear devices having a total of 42 megatons at a cost estimated at \$2.1 billion" compared with \$5.1 billion for conventional explosives.

Comparative Costs of Explosives

	Nuclear devices			Ammonium nitrate, fertilizer grade	40 per cent blasting gelatin, 2 × 16 cartridges	60 per cent blasting gelatin, 2½ × 16 cartridges	TNT
Charge for nuclear explosive	\$500,000	\$750,000	\$1,000,000	...	...	...	...
Typical cost of chemical explosives, per 100 lb	...	...	...	\$6.75	\$18.25	\$19.25	\$20.00[a]
Energy in nuclear explosion, Btu	4×10^{10}	4×10^{11}	4×10^{12}	...	...	...	...
Btu per dollar[b]	8×10^{4}	5.3×10^{5}	4×10^{6}	3×10^{4}	1.1×10^{4}	1.0×10^{4}	1×10^{4}
Relative cost of heat of explosion per million Btu	\$12.50	\$1.88	\$0.25	\$34	\$91	\$96	\$100

[a] Not being produced commercially today. Used almost solely as military explosive, with small amount added occasionally to proprietary explosives and boosters.

[b] Based on heat of explosion of 2000 Btu per lb for conventional explosives.

When subjected to direct pulling stress, a new self-bonding silicone rubber maintains its bond to the metal while the rubber itself slowly ruptures

Self-Bonding Silicone Rubber

A new family of high-strength, self-bonding, extreme-low-temperature silicone-rubber compounds and reinforced gums that afford a primerless bond to ferrous-containing metals stronger than the highest strength silicone rubber have been developed by the Silicone Products Department of General Electric, Waterford, N. Y.

Designated SE-5504U, they are expected to be of use to mechanical rubber fabricators in broad line processing and to specialty manufacturers for shock mounts, rubber rolls, oil seals, and a variety of other products where high-strength, trouble-free bonds are desired.

The number of steps involved in the silicone-rubber bonding process will be cut in half.

SE-5504U is a gray compound with a typical physical profile after cure of 25 hr at 350 F as follows:

Tensile strength, psi	1500
Tear, psi	200
Elongation, per cent	550
Durometer	50
Compression set 22 hr at 300 F, per cent	45

Excellent bonds have already been established to steel, chrome steel, and stainless steel, and other metals are being investigated.

Mar-Aged Steels

An 18 per cent nickel-alloy steel with unmatched toughness at the highest strength levels of traditional alloy steels has been discovered and developed by The International Nickel Company, Inc., at the company's Bayonne, N. J., Research Laboratory.

It is the only known material which has the ability to achieve a yield strength in excess of 250,000 psi while maintaining a nil-ductility temperature below −80 F. Notched tensile strength exceeds 400,000 psi (measured under the most severe test conditions with a notch radius of 0.0005 in.). The new alloy possesses a remarkable resistance to delayed cracking when exposed to a severe corrosive atmosphere in a highly stressed condition.

The new steel develops its high strength while maintaining unmatched ductility and toughness by means of an easy heat-treatment involving age-hardening of martensite. This extremely simple treatment has been given the abbreviated description of "mar-aging."

With proper finishing temperature off the mill followed by air cooling to room temperatures, the treatment consists merely of holding for about 3 hr at 900 F and air cooling. Solution annealing at 1500 F prior to mar-aging is optional. Quenching is not required, and full properties can be developed in heavy sections with no distortion problems.

The new steel has a nominal composition of 18 Ni-7 Co-5 Mo and less than 0.5 per cent Ti with a maximum of 0.05 per cent carbon. Higher and lower tensile strength can be obtained by modification of this basic composition. There are indications that high strength levels of up to 500,000 psi or even higher may be achieved in this type of steel. A 10-ton commercial heat has been produced by air melting in an arc furnace, and ingots as large as 23 × 42 in. from this heat have been rolled into plate on conventional steel-mill equipment. The 18 per cent nickel steel can be readily produced in all commercial shapes.

Unusually low work-hardening tendencies permit extensive cold forming and shaping with ease. The machining characteristics of the steel are excellent both as-rolled and even as fully hardened.

The 18 per cent nickel steel can be welded by either manual or automatic methods. Sound, crack-free welds are achieved, even on material in the fully heat-treated condition, without preheating. Postweld mar-aging restores the softened heat-affected zone of the parent plate to full strength and establishes in the weld metal properties closely approaching those of the base plate.

A patent application covering this new nickel steel has been filed with the U. S. Patent Office.

Northern Air-Source Heat Pump

High electrical load for light and power combined with a favorable power rate suggested an air-source heat pump when the Amherst, N. Y., Laboratory for the Electronic Systems Division of Sylvania Electric Products, Inc., was planned. Lack of smoke and fumes also recommended a heat pump since the laboratory is in a residential suburb of Buffalo, N. Y.

The design temperature called for was −5 F, and only water-source type installations had previously been made that far north. Pioneering was called for.

According to an article by the laboratory's plant engineer, Harry J. Pearl, in the March, 1961, *Plant Management and Engineering*, solid-rock foundations and a high-mineral-content ground water made a deep-well water-source system economically unsound.

The three-story 85,000-sq-ft structure required air conditioning throughout. Two identical systems are used. Each is composed of a 125-hp 16-cyl high-stage compressor that is run single-stage on the cooling cycle,

and a 75-hp 16-cyl low-stage compressor that acts as a booster during frigid weather.

Also a 40 × 40-ft utility wing houses two heat exchangers having water as a medium of exchange. Located directly overhead on the utility-wing roof are four air units which function as evaporators in the winter and condensers in the summer. Each system is independently connected on the Freon side; however, the circulating-water coils in the heat exchangers are connected in parallel.

Two purposes are accomplished with the two separate systems. In the event of failure of one system, the other is available as a standby. With the outside air dampers closed, one system will maintain building heat. Also, one system can furnish heat while the other is defrosting.

Periodic defrosting is necessary because the frost build-up during the heating season tends to reduce the efficiency of heat transfer. A liquid refrigerant which has absorbed heat is used to melt the frost.

An outdoor change-over thermostat automatically programs the heat pump to operate on heating or cooling. Change-over occurs at 55-F ambient.

The ratio of heating to cooling cost has been approximately 2 to 1 or about $6000 for heating and $3000 for cooling for the year. The annual cost for heating and cooling is estimated at $0.10½ per sq ft of building area.

The pump was supplied by the York Division of Borg-Warner, York, Pa.

Bearing Analyzer

A UNIQUE new bearing analyzer, for use while a bearing is in operation, is being developed for Tann Bearing Company division of the Tann Corporation, Detroit. The TEBA II (short for Tann Electric Bearing Analyzer) determines and plots curves of the coefficient of friction versus the parameter zN/p. It measures only the torque in test bearings while electronically eliminating the torque produced by the test mechanism.

The analyzer is being used for additional research on the Tann "Hyfilm" Bearing, first packaged bearing to run on a hydrodynamic oil film, and is expected to improve performance and standards for sleeve, shaft, and specialty bearings.

By varying loads and speeds, Tann engineers can determine with extreme accuracy the optimum operating conditions for any bearing configuration.

TEBA II enables engineers to determine the effects of design changes on bearing operation, including such factors as material selection and surface finish, types of lubricant, and variations in length-to-diameter ratios.

The first stage of TEBA II measures and records the operating temperature of test bearings. It also measures and records the amount of torque consumed in operating the bearing. Results are measured in inch-ounces.

It can test one or two bearings at a time, at any speed from 0 to 3500 rpm, and at any load from 0 to 200 lb.

TEBA II can automatically and continuously increase either load or speed or both from zero to maximum over any period of time from 1 to 8 hr. Load and speed are increased with infinite resolution.

Additional components, still to be added to TEBA II, will "listen" and record bearing noise and vibration and measure the effects of shaft misalignment.

When completed in 1962 the analyzer will also be able to measure with extreme precision shaft deflection and the thickness of hydrodynamic oil films which separate bearing members. It will also be able to continuously plot the path of the shaft as it moves from its static to dynamic position.

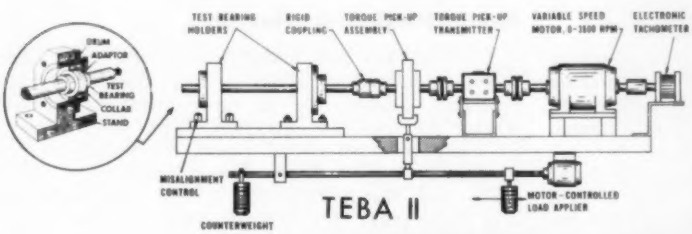
Without its complicated electronic circuitry the apparatus is essentially an electric motor with precise speed control and an extended shaft which drives the test bearings.

The test bearings are placed in a simulated-motor-housing mount which can duplicate bearing placements of integral-horsepower electric motors with NEMA 184 to 254 frames.

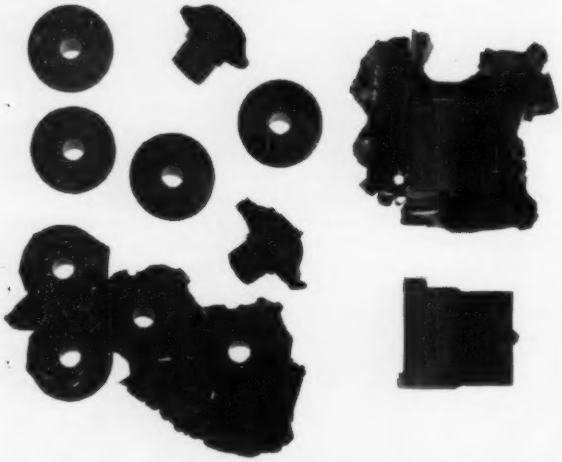
Sensitive thermocouples in the mount are placed in contact with the test bearing's outer housing.

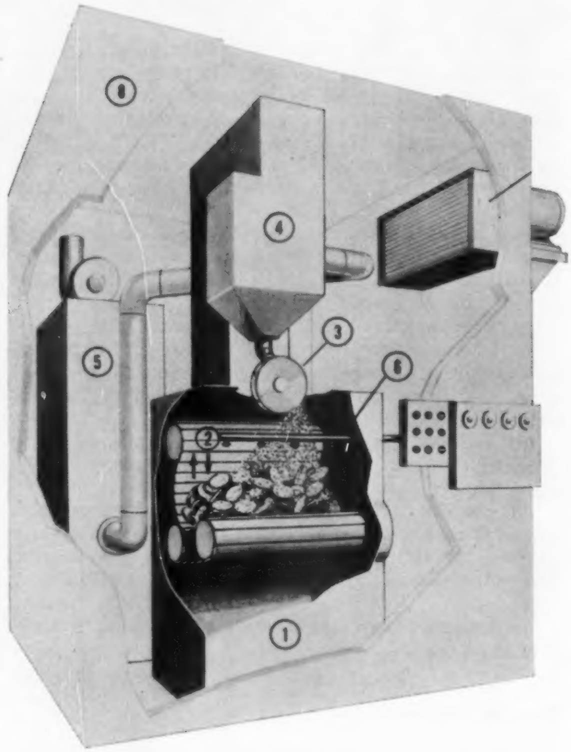
An unusual arrangement of electrical strain gages, mounted 90 deg apart in a Wheatstone-bridge network placed between the motor and the test bearings, measures only the amount of torque that is consumed by the bearings.

The device is so placed in the mechanism as to measure only the torque consumed by the test bearings, eliminating torque and vibration from the mechanism of the test equipment.



Operating temperature, amount of torque consumed, bearing noise and vibration, and effects of shaft misalignment can all be measured and recorded for one or two operating bearings at a time at any speed from 0 to 3500 rpm and at any load from 0 to 200 lb. Load and speed can be automatically and continuously increased from zero to maximum over any period of time from 1 to 8 hr.





"Wheelabrator" rubber deflashing machine removes flash from molded rubber parts. First flash is frozen to make it brittle. Then, in a shot-blast-like operation, the frozen flash is broken from the parts.

Key to the machine components:
1 Rubber deflashing machine—2 cu ft workload.
2 Slow conveyer exposes parts to deflashing blast. (Parts unloaded by reversing conveyer.)
3 Wheelabrator unit throws controlled pattern of media at parts to be deflashed.
4 Media cycling and cleaning system.
5 Dust collecting and ventilation system.
6 Liquid CO system for freezing of flash.

Mechanical Rubber Deflashing

To REMOVE molding flash from molded rubber products, Wheelabrator Corporation has developed a combination freezing and impact process.

Essentially, the process consists of introducing molded rubber parts into the 2-cu-ft work chamber of a Wheelabrator Deflashing Machine that is enclosed within an insulated cabinet. While in this chamber, liquid CO_2 is sprayed through nozzles to freeze the flash on the parts (not the parts themselves). Next, media particles are hurled by centrifugal force against the parts, fracturing and removing the frozen flash without damage to the soft unfrozen part.

The complete unit comprises a Deflashing Machine and a Dust Collector, the latter being used for ventilating the operation and for removing impurities from the media supply. Both of these units are completely contained within a fully insulated enclosure.

The CO_2 freezes the flash, making it brittle and easy to remove by the impact of the media. The process is limited to parts where the molder can control his flash to within 0.005 in. or less. The part itself, being thicker, is not frozen and hence is less subject to breakage, fatigue cracks, or surface abrasion.

A work conveyer of the endless steel-slat type provides a gentle cascading action which presents all parts and all surfaces of each part to the top of the moving mass within a very short period of time. The media hurling device is an eight-bladed wheel that utilizes centrifugal force to hurl minute spherical particles in a controlled pattern across the width of the deflashing chamber.

Media particles are specially selected spherical steel pellets within a size range of 0.007 to 0.017 in. in diam and with a nominal size of 0.011 in.

As an indication of the speed of deflashing possible, the wheel unit will actually hurl over 20 million particles a second, or 350 lb of media a minute. For practical purposes, the deflashing occurs as soon as a part with frozen flash is exposed to the media barrage.

Supercritical-Water Reactor

A SURVEY has been undertaken to determine whether sufficient technology exists to make possible a realistic economic analysis of a supercritical-water nuclear reactor for power generation. The practicality and efficiency of supercritical plants for fossil-fuel power generation have already been demonstrated by the Eddystone, Breed, Philo No. 6, and other such plants. The Philo plant, for example, employs seven stages of feedwater heating and two stages of reheat and operates at an over-all efficiency of 46.7 per cent.

To attain comparable efficiencies, a supercritical-water nuclear plant probably must operate on the direct cycle, and such operation is recommended as the most promising in the study made by Argonne National Laboratory. It is reported in the March, 1961, issue of *Power Reactor Technology* prepared for the U. S. Atomic Energy Commission by General Nuclear Engineering Corporation.

The Argonne survey drew upon three supercritical-water-reactor sources for data: (*a*) The direct-cycle aircraft nuclear propulsion, ANP, project of Pratt & Whitney; (*b*) a maritime evaluation of an indirect-cycle plant by Westinghouse Atomic Power Department, WAPD; (*c*) a conceptual direct-cycle design prepared by Hanford Atomic Products Operation, HAPO.

Of the direct-cycle designs, Pratt & Whitney's, now terminated, established considerable background on component development, materials investigation, corrosion work, and heat transfer, but was too compact and too high in power density for a central station. Only the HAPO study dealt with the design of a central station.

HAPO would be a 300-tmw, 130-emw plant, based upon Philo conditions, cooled by H_2O at 5000 psi and moderated by cool D_2O. Gross cycle efficiency is estimated at 43.3 per cent. The steam pressure at the turbine would be 4500 psig with a flow of 675,000 lb per hr.

Fuel elements, which present some development problems, would be full-core length, consisting of relatively massive columns of UO_2. These would be penetrated axially by Inconel-X coolant tubes to confine the high-pressure coolant and separate it from the fuel. There would be 12 tubes in each fuel element and groups of two connected in series at the bottom to provide a return-flow arrangement. A surrounding layer of granular ZrO_2 would provide thermal insulation, and there would be an outer zirconium can with further insulation provided by a helium-filled gas space.

The coolant flow sequence is a complex one, involving four complete passes through the reactor per cycle (each pass consists of the downward and upward flow through a fuel element). Coolant enters the reactor at 525 F and is heated in two passes through the reactor to 1150 F. It then flows through a heat exchanger to provide reheat for the steam cycle. A third pass brings the coolant back to 1150 F. It is then passed through a second reheat exchanger. A fourth reactor pass brings it back to 1150 F before the steam enters the high-pressure turbine. In its expansion cycle the steam flows through the following: The high-pressure turbine, a reheater, a reheat turbine, a second reheater, a second reheat turbine, and, finally, the low-pressure turbine.

Power cost estimates arrived at by scaling those for the Plutonium Recycle Test Reactor, PRTR, for a 125-emw-net plant would range from 6.9 to 8.1 mills per kwhr depending on fuel-fabrication cost assumptions.

The major gap in supercritical-water technology is the unknown magnitude of radioactivity in the external system and of the buildup of internal crud under irradiation.

Low-cross-section materials for more than 1000-F and 3000-psia service are not on hand, and, as in the case of steam-cooled reactors and superheater reactors, the stainless steels and the nickel alloys appear to be the least absorptive practical and dependable materials. HAPO's internal pressure-tube fuel-element arrangement is directed toward minimizing neutron loss to absorptive structural materials.

Types 347 and 316 stainless steels, approved by the ASME Boiler Code, appear to be usable for the portions of the plant outside the reactor core. The main steam piping for the Philo plant is of Type 347 stainless steel, whereas the Eddystone plant will employ piping of Type 316 stainless, steel made by the forged and bored process.

Ultrasonic Grinding-Wheel Cleaner

Ultrasonic energy in the 20,000-cps range is used to prevent "loading," the buildup of metallic debris between the abrasive particles on the cutting edges of production grinding machines. It is this buildup which causes the wheel to become smooth and lose its cutting power, requiring redressing with a diamond until a fresh and rough grinding surface is exposed.

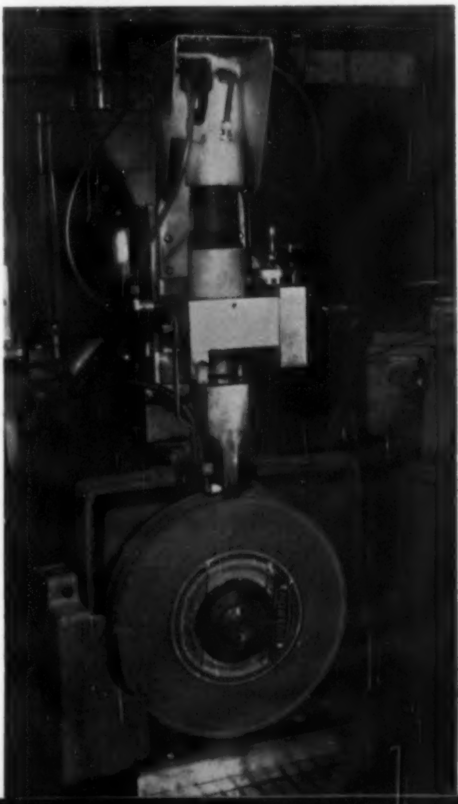
The device known as Ever-Grind has been introduced by Cavitron Corporation, Long Island City, N. Y. It uses a magnetostrictive transducer as the source of intense ultrasonic vibrations at the rate of 20,000 cps. The transducer is driven by an ultrasonic generator which converts 60-cps line currents into ultrasonic frequencies. An activity meter on the face of the unit permits tuning the transducer to optimal frequencies.

An aluminum tool head the size of a cigarette package is attached to the end of the transducer and positioned a few thousandths of an inch above the rotating grinding wheel. It delivers the ultrasonic energy through a coolant interposed between the vibrator and the rotating wheel in which cavitation results in the formation of thousands of bursting bubbles per second.

The reciprocating tool head, the cavitating coolant, and the geometry of the structure, coupled with the rotating wheel, establish a complex set of physical conditions which produce a very effective force field at the wheel surface to inhibit loading.

Production-run studies are claimed to show that, in addition to eliminating down time for redressing wheels, wheel life is extended, reducing the size of the wheel inventory. It also insures a minimum of burning and work deformation, permits use of upgraded harder wheels, insures flatter work and finer surface finishes, provides greater dimensional accuracy, and helps grind difficult metals more economically. Abrasive cutting edges and wheel leading edges are maintained, thus permitting cutting going and coming.

Accessory for grinding wheel prevents buildup of metallic debris. Force field set up through ultrasonic vibrations keeps wheel clean.



Artist's conception of aircraft redesigned to test the Laminar Flow Control system which is expected to increase range, payload, or endurance by 50 per cent or more. The method increases performance by decreasing friction drag. Compressors in the wing pods suck in air through paper-thin slots to prevent boundary-layer turbulence.

Laminar-Flow Aircraft

Design details of air-inhaling wings used to obtain extended range have been disclosed by the Northrop Corporation.

Two former WB-66D weather reconnaissance aircraft are being rebuilt by Northrop's Norair Division in Hawthorne, Calif., to demonstrate the company's performance-stretching Laminar Flow Control, LFC, system under all flight operating conditions. This three-year, $30-million program is sponsored by the U. S. Air Force Systems Command.

LFC is expected to extend the range, flying endurance, or payload of large aircraft 50 per cent or more without increased fuel consumption. The LFC wing will be extra large and the aircraft's twin jet engines will be mounted on the aft fuselage. The wing will "inhale" air through many fine slots cut in the wing surfaces to eliminate up to 80 per cent of the friction drag on the wing, without sacrificing structural strength.

The slots are so fine that they cannot be seen from a distance of more than a few feet. Suction turbines suck air through the slots and exhaust it rearward to eliminate the air turbulence that causes most of the friction drag.

When an aircraft is in flight, a thin stratum of air, called the boundary layer, flows across the aircraft skin. It flows slower than the surrounding air.

Boundary-layer flow is smooth (laminar) at its beginning, but becomes turbulent as it passes along the aircraft skin. Turbulent friction drag is many times larger than the corresponding laminar friction drag. Laminar flow over a large percentage of the wing can be maintained by means of boundary-layer suction through a large number of fine slots. The suction air is then carried through the suction ducts into the suction compressors and is then exhausted in flight direction to obtain additional thrust.

The LFC wing will have a span of 93.5 ft, compared with 72.5 ft for the WB-66D. Wing area will be increased from 780 to 1250 sq ft. With friction drag nearly eliminated, the drag due to lift can be reduced by increasing the wing span, Northrop engineers explained.

General Electric J-79 engines will be substituted for the aircraft's former J-71 power plants. The engine nacelles will be mounted on the aft fuselage, a design feature which is found on many of the newest transport aircraft such as the Sud Caravelle and the Boeing 727.

Suction turbines will be mounted beneath the wings where the engine nacelles were located. The pumping system is being developed by the AiResearch Manufacturing Division of Garrett Corporation.

Laminar Flow Control was formerly known as low-drag boundary-layer control. Lt. Gen Bernard A. Schriever, commander of the Systems Command, has called it "a real break-through" in the Air Force's 10-yr search for a method of extending range and endurance without increasing aircraft gross weight.

Much of Northrop's pioneering research and development in this specialized field were carried out under Systems Command sponsorship.

The research was directed by Werner Pfenninger, a Swiss-born authority in the field of low-drag boundary-layer control.

The Laminar Flow Control aircraft project is managed by Milton Kuska, Norair Division engineering executive who was formerly director of Flight Test Engineering.

Vacuum-Freezing Water Desalting

Line production is scheduled to start this year at the Beloit, Wis., plant of Fairbanks, Morse, of a sea-water conversion unit jointly developed by the company and the State of Israel. The machine evolved from the vacuum-freezing process developed by Alexander Zarchin, an Israeli scientist.

The cost of producing fresh water is expected to be below the $1.75 per 1000 gal of the most economical unit now in use anywhere.

The first desalting unit which will produce approximately 250,000 gpd of fresh water will be installed at Elath, gateway to the Red Sea.

Univac LARC II

The Univac LARC II, claimed to be the largest electronic computing system in current operation, has been installed in the Applied Mathematics Laboratory, David Taylor Model Basin, Washington, D. C.

Built by the Remington Rand Univac Division of Sperry Rand Corporation, the Univac LARC is many times faster than existing computer systems.

The David Taylor Model Basin is a complex of four Laboratories operating under the Navy's Bureau of Ships—Applied Mathematics, Hydromechanics, Aerodynamics, and Structural Mechanics Laboratories.

The Applied Mathematics Laboratory, established at the David Taylor Model Basin in December, 1952, is one of the most complete computer facilities in the world. In addition to the Univac LARC system, two Univac I computers, an IBM 7090, and specialized computer auxiliary devices are used. The Laboratory performs computations and analyses for the Bureau of Ships and its laboratories and other agencies of the federal government.

Officials said the Univac LARC system makes feasible for the first time efficient studies of three-dimensional mathematical models of nuclear reactors. LARC can simulate the lifetime behavior and calculate, in just a few hours, the performance of various components throughout the power-producing life of the reactor core.

The new computer technique greatly reduces requirements for pilot-model construction, which often take years. The LARC studies and compares many different reactor designs and selects the most efficient design for a specific purpose.

Ship designers at the Laboratory will determine ship lines and the contours of a ship's hull on the new computer rather than laying them out full scale in a builder's loft, the time-consuming method now used. A digital method will also be developed for spectrum analysis of ocean-wave patterns.

The Univac LARC II performs 250,000 additions or subtractions per sec and its speeds are rated in nanoseconds—billionths of a second.

The giant solid-state almost completely transistorized electronic computer contains over 80,000 transistors and 600 vacuum tubes in the two interconnected computers and associated auxiliary devices which make up the system. The high-speed magnetic-core memory stores up to 360,000 characters and an additional 36 million characters can be stored on 12 high-speed memory drums which transfer information at speeds up to 1,323,000 characters per sec. Supplementing the high-speed drums are 16 magnetic-tape units which are also used to put data into and take them out of the system. Results are produced by a high-speed printer at the rate of 600 lines per min.

Rolled Structural Shapes

Rolled structural shapes are being commercially produced from quenched and tempered alloy steels by U. S. Steel Corporation. Heat-treated to design strengths as much as three times that of structural carbon steel, the new shapes are said to promise important weight and cost savings in a host of structural applications.

The new shapes will eliminate the need for many customers to cut quenched and tempered alloy-steel plates and weld their own structural sections. Ready rolled shapes of USS T-1 or T-1 Type-A constructional alloy steel, for example, will cost only slightly more than the quenched and tempered plate material. By using them, customers can realize savings of about 30 per cent as compared to the cost of fabricating similar shapes in their own shops.

Furnished in standard I-beams, channels, and angles, and in lengths up to 40 ft, the new shapes are produced from several of U. S. Steel's best-known quenched and tempered alloy compositions. These include: USS T-1 and T-1 Type-A constructional alloy steels; 9 per cent nickel steel for cryogenic applications at temperatures as low as −320 F; and HY-80 naval armor steel.

Designers can now specify off-the-shelf shapes of T-1 steel which have a minimum yield strength of 100,000 psi, about three times that of structural carbon steel. These shapes have the same toughness and excellent weldability as T-1 steel plates, which have virtually revolutionized the design of pressure vessels and many types of earthmoving, mining, and transportation equipment since they were introduced in 1953.

An even bigger market may develop for quenched and tempered shapes of T-1 Type-A constructional alloy steel, which U. S. Steel introduced in plate form last December.

In thicknesses through 1 in. this material has the same yield strength, weldability, and notch toughness as the original USS T-1 steel. Yet, where structural sections 1 in. thick and under will serve the designer's needs, the chemical composition of T-1 Type-A makes it more economical.

Major markets exist for quenched and tempered structural shapes of USS T-1 and T-1 Type-A constructional alloy steels in two distinct areas.

One will include machinery and equipment, especially mobile types, where the prime object is to carry the biggest possible payload with the least amount of dead weight.

This design concept applies to trucks, trailers, railroad and mine cars, barges, portable drilling rigs, bulldozers, power shovels, cranes, missile transporters and launchers, and many other items.

The other major market will include stationary structures.

Special clamp holds structural steel shape firmly during heat-treat to prevent distortion in the rapid cooling cycle. Wafflelike pattern lets water flow uniformly to quench all areas of the channel.

Behind the Scenes of the Space Age

PHOTO BRIEFS

M. BARRANGON

Before that satellite goes into orbit, an army of mechanical engineers has been at work—power, nuclear, metals, heat transfer, aviation, applied mechanics, fuels, hydraulics, lubrication . . .the many disciplines are called upon to produce as never before. Here's a glimpse of them at work.

1 **New Career for a Generator.** For 40 years, this 52-ton generator powered the Boston, Mass., subway system. Now, at the Palo Alto laboratories of the Lockheed Missiles and Space Division, it contributes to the space age by furnishing tremendous heat to the 1-ft-diam power chamber of a high-speed wind tunnel. Not all the imagination for the space age goes into far-out engineering. Now and then, somebody has to use down-to-earth horse sense—and somebody did.

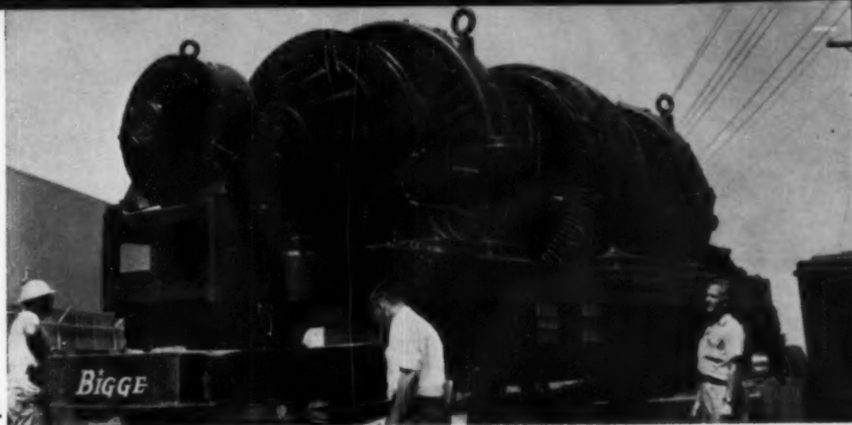
2 **Fork Truck for Rocket Motors.** Accidental ignition of a rocket's solid fuel just wouldn't pay. To preclude any chance of a spark, this diesel truck has conductive rubber tires, aluminum fan blades, bronze carriage bushings, nickel-plated rollers in the carriage and upright, and a water muffler. It operates without an electrical system, the engine being started hydraulically and all gages being mechanical, not electrical. The special fork truck, of 18,000-lb capacity, was made by the Industrial Truck Division of Clark Equipment Company, Battle Creek, Mich.

3 **How to Make a Space Capsule.** You recognize this structure, but have you seen it in its underwear? Strips of Johns-Manville Min-K insulation are laid on top of the ribs that separate the inner and outer skins. When the outer skin is bolted on, the Min-K isolates it, blocking a through thermal path. At **right center** can be seen one of the hydrogen-peroxide thrust chambers for the control system (enabling the astronaut to modify capsule orientation during orbit).

4 **Gas Bearing.** You'll need this for your rocket and your satellite. The scene is at Boeing, in Seattle, and they're operating this bearing at such low temperatures that the nitrogen-gas lubricant has become liquid. They can also operate it at high temperatures (the range: from —330 to +600 F). This is a step bearing, in which a slight recess in the bearing shaft receives the pressurized gas which lifts the shaft and becomes the lubricant. The gas flow is throttled as it escapes from the recess. Speeds: Up to 100,000 rpm.

Long Life for a Satellite. At Bell Telephone Laboratories, solar cells and protective transparent sapphires are attached to a developmental model of a communications satellite. Sapphire protection will enable cells to function for many years in orbit. See the Cover Story, p. 3.

It's a SNAP. Up at the top of that missile nose cone mockup is one of the SNAP (Systems for Nuclear Auxiliary Power) space reactors, one developed by Atomics International, a division of North American Aviation. Man **second from the left** is Chairman Glenn T. Seaborg, of the AEC. **Far left,** Dr. Chauncey Starr, president of Atomics International.



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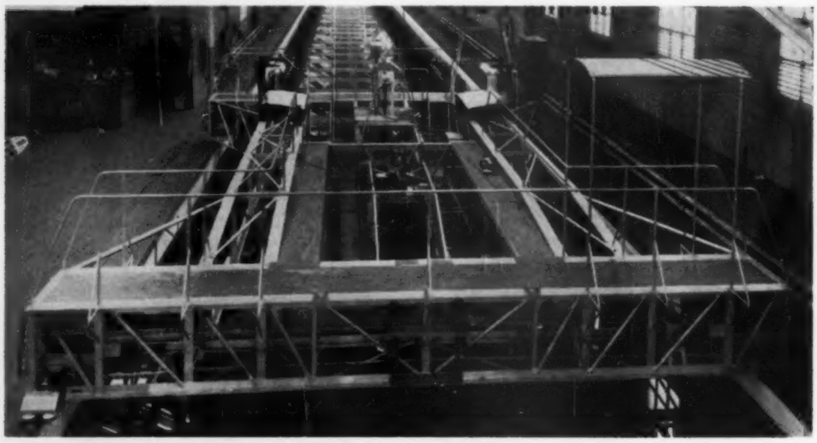
Engineering Progress in the British Isles and Western Europe

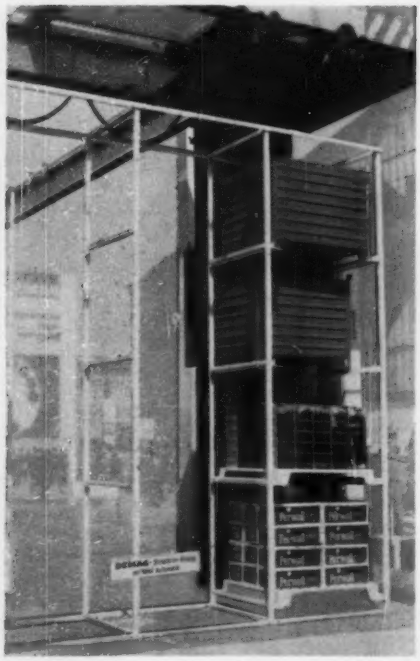
J. FOSTER PETREE
European Correspondent

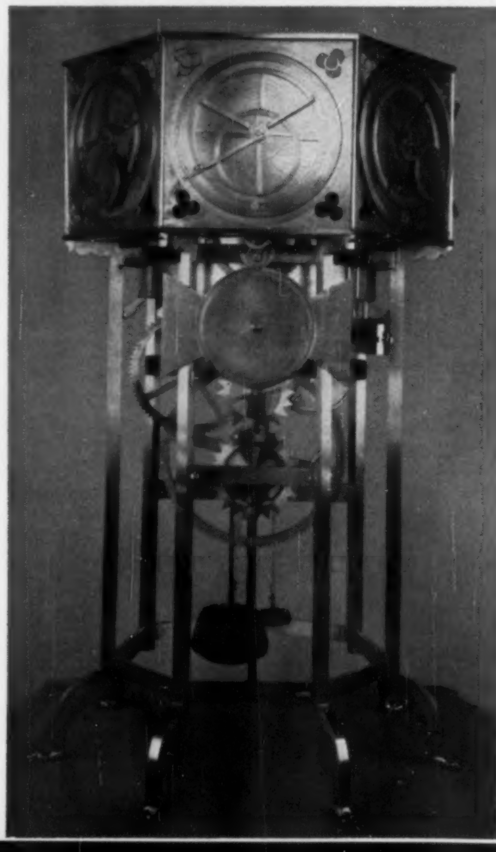
EUROPEAN SURVEY

Light Alloy Carriage. This towing carriage of aluminum-alloy tubing has replaced one of wood-frame construction in the ship-model towing tank in a Clydebank shipyard in Scotland. The structure was electrically welded.



Push-Button Storage. This compact stacker-crane installation for stores is being shown at the German Industries Fair, Hanover. Storage bins are picked up by crane, automatically transferred, and slid into compartments. System is operated from a control desk.





Astronomical Clock. Recently constructed brass duplicate of astronomical clock built in 1364. Its dials keep the hours and minutes of the day, as well as star time, the day of the month, motions of the sun, moon, and five other planets; saints' days, and the motion of the Nodes. It is on display in Washington, D. C.

Astronomical Clock

In 1364, after 16 years of work, Giovanni de Dondi, an Italian professor of astronomy, completed the world's first astronomical clock. It remained in Italy until 1585, when it was taken to Spain by the Emperor Charles V, who deposited it in the convent of San Yste. There it apparently was destroyed when, in 1809, the convent was set on fire by French troops during the Peninsular War. Dondi, however, had left drawings and a full description of the clock. Copies of these rest in the Bodleian Library at Oxford, England. From them a British expert on ancient clocks, H. Alan Lloyd, and a London firm of clockmakers, Thwaites & Reed, have constructed a duplicate by order of the Smithsonian Institution, Washington, D. C. The duplicate is made entirely of brass, as was Dondi's original, and shows not only ordinary time in hours and minutes, but sidereal or star time, the day of the month, the length of daylight for every day, the times of the rising and setting of the sun, the motions of the sun, moon, and the five planets known in Dondi's time; saints' days, and—perhaps the most remarkable single feature—the motion of the Nodes on a dial over which the hand makes one revolution in $18^1/_2$ years. In addition, there is a perpetual mechanical calendar for Easter, an accomplishment which was not repeated until nearly 500 years later. Another astonishing achievement of Dondi was that of realizing, and mechanically reproducing, the moon's orbit as an ellipse, and not as a true circle. In this he was nearly 400 years ahead of his time. The whole of this complicated mechanism, consisting of seven main dials, is driven by a weight-actuated clock movement. This in itself is remarkable, for so far as is known weight-driven clocks were introduced only about 50 years before Dondi perfected his design. The clock, surrounded by drawings and prints of Dondi's manuscript in Latin, was on exhibition at the Science Museum in London for several weeks before shipment to the Smithsonian Institution.

Light Alloy Carriage

The ship-model towing tank in the Clydebank shipyard of John Brown & Co., Ltd., Scotland (where the Cunard liners *Lusitania*, *Queen Mary*, and *Queen Elizabeth* were built), was installed in 1903. The original installation had a wood-framed towing carriage designed by R. E. Froude. After having traveled some 21,000 miles up and down the tank in the course of carrying out about 150,000 experiments, this has been replaced by one of aluminum-alloy tubing that provides much more space for the dynamometer, recording instruments, and other equipment. The alloy used was "M.G.5" magnesium-aluminum, and the structure is electrically welded throughout by the Argonarc process. Each of the four driving wheels has its own 5-hp electric motor, the drive being transmitted by duplex chain. The power supply is on the Ward-Leonard loop system, connecting a shore-based generator with the four wheel motors in series. Speed control is effected by regulating the voltage of the generator, which is excited by a magnetic amplifier. By this means the operator can set the main speed-control potentiometer to any desired final speed. Automatic acceleration is obtained merely by closing the main contactor. The current is collected by a trolley boom from 11 overhead wires that provide supplies at 240 volt a-c, 220 volt d-c, and 12 volt d-c for the various driving and recording purposes. Dunlop disk brakes are fitted to the four driving wheels and are operated from one master cylinder and solenoid. Emergency hand brakes are fitted to the rear wheels. An overhead cut-off stops the carriage automatically at the end of its run.

German Industries Fair

With each year that passes, the German Industries Fair at Hanover continues to grow. This year, three new exhibition halls have been brought into use, making a total of 20 in addition to the large area of open-air stands.

Though originally intended to be wholly German, the Fair has admitted for some years exhibitors from other countries, and it is notable that in 1961 the number from the United States has increased to 127, as compared with 90 last year, causing the U. S. to move up from the fifth to the second place in the list of non-German participating countries.

Mechanical handling in all its forms, excavators and earth-moving equipment, machines for the processing of plastics and rubber, and mechanical-engineering components such as gearing, chain and other transmissions, refrigerating machinery, oil burners, and heating and ventilating equipment of all kinds were much in evidence; and, as in former years, the big steel firms made impressive contributions.

Push-Button Storage

Among the mechanical-handling exhibits at the Hanover Fair was a compact stacker-crane installation for stores, shown by Demag-Zug GmbH, of Wetter (Ruhr), Germany. Operated by automatic control, this equipment will stack goods up to a height of 35 ft in racks separated only by the width of one container. After a particular storage bin has been picked up by the crane, the required rack compartment is dialed on the control desk, each compartment having a three-figure number which defines its position. The crane then travels automatically to that destination, slides the bin into the compartment, deposits it and withdraws the fork, and then returns to the loading point. Bins are removed from the rack in a similar way, the whole cycle being entirely automatic. A panel of pilot lamps enables the movements to be followed by the operator at the control desk. In layout, the system bears some resemblance to that used by the Fiat automobile works in Italy in their spare-parts store; but in the Fiat plant the operator travels on the crane, moving it vertically and horizontally until he can slide the bin into its place, whereas in the Demag installation the operator remains on the floor. As the crane carries only the bin, it can be correspondingly more compact.

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Substance in Brief of Papers Presented at ASME Meetings

ASME TECHNICAL DIGEST

Aviation/Space

Lightweight Thermal Insulation by Transpiration Cooling . . 61—Av-1 . . . By John G. Krisilas, Assoc. Mem. ASME, and John E. Boberg, Lockheed Aircraft Corporation, Burbank, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The subject of supersonic flight has evoked much interest during the past decade in the aircraft industry. Recently, added impetus was obtained by the advent of the B-70 bomber program and the various commercial supersonic transport studies being published. The subject matter of this paper deals with one major problem area common to all high-Mach number vehicles—the necessity of providing a highly effective thermal barrier to protect the interior crew and passenger compartments and equipment areas from the effects of the high exterior skin temperatures arising from aerodynamic heating.

By directing air through a porous insulating material counterflow to the direction of heat flow, an effective barrier to the heat flow is formed as determined by analytical and laboratory tests. Air flow rates, material density, and configuration orientation were investigated. This concept may be applied to any high-speed vehicle for protecting passenger and equipment compartments from aerodynamic heating.

Catalytic Filtration of Ozone in Airborne Application . . 61—Av-2 . . . By John E. Boberg and Myron Levine, Lockheed Aircraft Corporation, Burbank, Calif. 1961 ASME Aviation Conference paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Jan. 1, 1962).

The presence of ozone in the atmosphere has been known for over a hundred years. Its existence is largely due to the photodissociation of oxygen molecules (O_2) into oxygen atoms (O) by ultraviolet sunlight, followed by the formation of ozone through a three-body collision reaction involving the oxygen atom and an oxygen molecule. Because energy from another part of the sunlight spectrum dissociates the ozone molecule, the concentration of ozone in the atmosphere remains below a certain equilibrium value at each altitude.

Studies were undertaken to determine a practical method of reducing the ozone content of cabin intake air typical of high-altitude, high-speed aircraft. To make use of the aircraft ram air temperature rise, catalytic filters were investigated for purposes of ozone destruction. The effective temperature range and life of the more promising catalytic materials were investigated. A brief study of ozone adsorptive materials at lower temperatures is included.

A New Mechanical Approach for the Construction of Modular Electronic Equipments . . 61—Av-3 . . . By R. C. Swengel and W. R. Evans, Assoc. Mem. ASME, AMP Incorporated, Harrisburg, Pa. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

In order to implement reliability and achieve economic maintainability for both simple and complex electronic equipments, a new mechanical structure has been devised. Based on an incremental form rather than a fixed size module, the new structure is adaptable to both the present and probable future techniques of the electronics industry. The fabrication and production processes are compatible with automatic machine techniques as well as small-lot production.

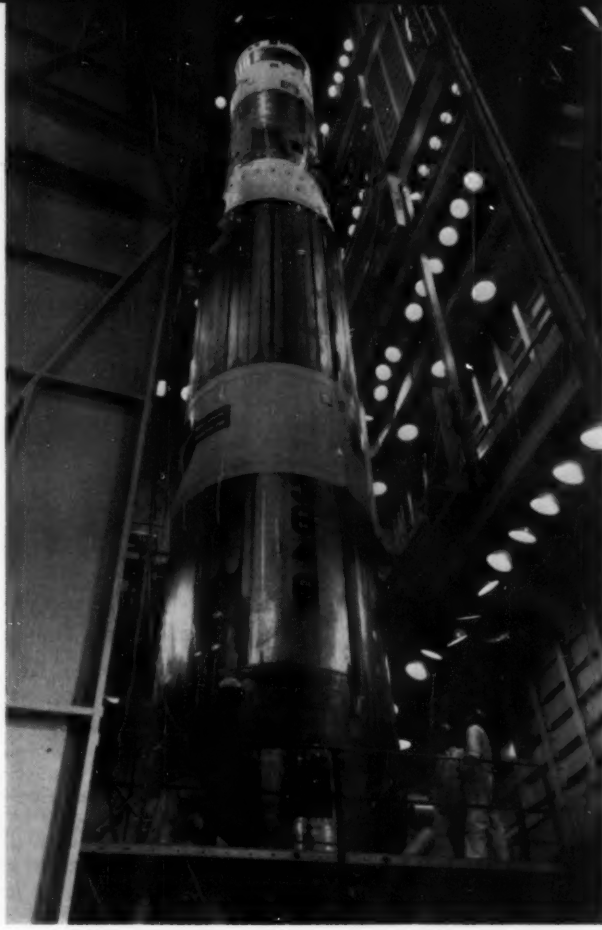
Thermal Design for Microminiaturized Circuitry . . 61—Av-5 . . . By H. C. Kammerer, Assoc. Mem. ASME, International Business Machines Corporation, Kingston, N. Y. 1961 ASME Aviation Conference paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Jan. 1, 1962).

Now that a number of techniques exist that permit the fabrication of circuits with a theoretical packing density of one million or more circuits per cu ft, thermal design is an essential initial consideration. In most cases the drive toward microminiaturization is based on the need for a large number of circuits in a small weight and volume. If present circuit designs are taken as the basis for microminiaturization, it can be shown that with most materials being considered the temperature will rapidly rise to the point where circuits will become inoperative.

This paper outlines some of the basic considerations in terms of heat conductivity of materials, maximum safe working temperatures, and circuit power levels as dictated by current devices. A method is described whereby a proposed design configuration can be computer-analyzed in terms of isothermal lines and maximum hot-spot temperatures, and decisions made on that basis as to which type of cooling is most appropriate.

Forming of Hi-Temperature Metals . . 61—Av-6 . . . By I. J. Wilson, North American Aviation, Inc., Los Angeles, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

In an effort to achieve minimum weight, new design concepts have evolved that impose more exacting requirements on forming and fabrication than ever before in the aircraft industry, particularly in sheet-metal parts. The extensive use of brazed steel honeycomb panels has created many problems. Sheet-metal details must be formed to tolerances of ± 0.002 in. Comparing this to the standard sheet-metal forming tolerance of $\pm 1/_{32}$ gives some indication of the magnitude of the problem. Conventional sheet-metal structure has also undergone a change in the interest of saving weight. Designs requiring fewer pieces result in larger and more complex shapes. Forming is further complicated



Titan missile being mounted in 13-story vertical test fixture for structural tests and verification and final systems tests. Areas in relief have been chemically milled to remove metal to a thickness of 0.050 in. where strength is not necessary (61—Av-69).

by such material characteristics as low ductility, high springback, transformation growth, and warpage during heat-treatment. The use of very thin sheet gages compounds the difficulty.

The author deals with the methods and techniques that have been developed to form parts from the sheet materials that lend themselves to structural components subject to elevated-temperature use. The text is divided into four parts according to the material types—precipitation-hardening stainless steel, H-11 type tool steel, heat-treatable titanium alloys, and nickel-base alloys. Each section is complete in itself, discussing the problems and solutions peculiar to each material according to its use.

Measurement of Four-Pole Parameters of Complex Structures..61—Av-7... By F. B. Safford, Nortronics Division of Northrop Corporation, Hawthorne, Calif. 1961 ASME Aviation Conference paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Jan. 1, 1962).

The requirements for adequate lightweight structures for electronic, optical, and precision mechanisms in missiles, spacecraft, and military aircraft have demanded the development of both new approaches and applications of old techniques. In recent years, the concept of equipment fragility has been evolved, the application of random vibration for dynamic environmental simulation is being used, and mechanical impedance methods both analytical and experimental are being explored. In the latter case, the use of four-pole-parameter theory in vibration analysis has demonstrated considerable promise. Essentially this system relates the input and output quantities of force and velocity by a structural matrix.

A method of measurement of the four-pole parameters of a system as a function of frequency is presented. This procedure consists of no-load dynamic measurements followed by measurements under a known load. From the foregoing measurements, the four-pole parameters of a system are derived. Application is made to an electrodynamic motion exciter with graphical presentation of the parameters with respect to amplitude, phase angle, real, and imaginary parts.

Titan Testing..61—Av-69... By James Cook, The Martin Company, Denver, Colo. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

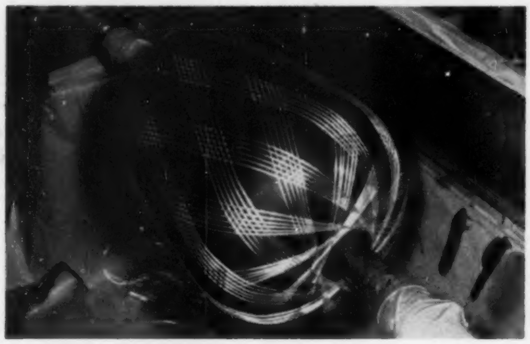
The Titan weapon system progressed from blueprints to successful flight in 40 months. The building of a completely new, integrated facility played the major role in accomplishing this feat. The testing program, which is described, is also of great importance because it has exposed problem areas at the earliest possible time. This has permitted rapid design modification.

The Titan testing program may be visualized as a pyramid resting on a broad base made up of thousands of tests of parts, assemblies, and components. The next higher level of testing deals with subsystems and their relationships and compatibility with one another. Captive firing tests make up the third level of the pyramid. This operation permits a final check of the complete missile without subjecting it to damage or destruction. Since the intercontinental ballistic missile is a "one shot" weapon, this is an important consideration. At the apex of the pyramid is the flight test, the only major part of the program that is not carried out at the Denver facility.

The Use of Derivative Pressure Feedback in High Performance Hydraulic Servomechanisms..61—Av-4... By T. R. Welch, Hughes Aircraft Company, Culver City, Calif. 1961 ASME Aviation Conference paper (in type, to be published in **Trans. ASME—J. Engng. for Indus.**; available to Jan. 1, 1962).

Hydraulic servomechanisms are sometimes used to drive a load member that is predominantly inertia. The usual overriding requirements for output disturbance discrimination and high power efficiency dictate a simple closed center, flow type, servo valve, and a positive displacement actuator. The resulting transfer function relating output velocity

Thrust chamber parts, **right**, were explosively sized. Parts are formed explosively with the aid of a die set in a pit, an explosive being detonated inside the workpiece. Helical pattern, **below**, is one of many used in filament winding, another advanced fabrication technique (61—Av-13).



to servo valve input current invariably includes an underdamped quadratic lag due to fluid compliance. In simple hydraulic servo systems, the corner frequency of this quadratic lag represents the absolute limit to system bandwidth.

Pressure feedback systems have been devised to damp the fluid resonance so effectively that bandwidth extension beyond the quadratic corner frequency is entirely feasible. Unfortunately, such a scheme destroys the natural output disturbance discrimination inherent in the closed center hydraulic systems.

A hybrid method of compensation is proposed whereby pressure feedback occurs only in the region of the resonant frequency, effectively preserving the natural output disturbance discrimination characteristics at the lower frequencies. The pressure drop across positive displacement type hydraulic actuators is a good measure of acceleration. Therefore the technique involves feeding back this load differential pressure, sensed by electromechanical transducers, through a simple RC high pass (derivative) filter. The effectiveness of the damping is determined by the filter time constant and loop gain. Experimental results verify linear predictions of the possibility of extending the closed loop bandwidth beyond the uncompensated resonant frequency.

Maintainability—A Design Characteristic of Equipment..61—Av-9...By John A. Sahs, Chrysler Corporation Missile Division, Detroit, Mich. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

Maintainability is discussed as a design characteristic that limits or facilitates the performance of the maintenance functions programmed for a weapon system. A method of defining and evaluating maintainability characteristics is presented which uses maintenance time as the criterion for evaluation. The success of applying the maintenance time factor as a measure of maintainability is dependent upon first establishing an optimum value-cost ratio for the programmed maintenance functions in a weapon system.

Advanced Fabrication Techniques..61—Av-13...By R. Gorcey, J. Glyman, and E. Green, North American Aviation, Inc., Canoga Park, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The ever-increasing requirements of this space age result in extremely demanding new designs and materials. As a result, advanced fabrication techniques must also be developed to keep up with these new design and material developments.

This paper discusses three advanced fabrication techniques currently in use at Rocketdyne. These techniques are filament winding, explosive forming, and furnace brazing. Among the items discussed for each technique are the process, advantages, applications, economics, and design considerations.

A Micromodule Missile Autopilot..61—Av-18...By J. H. Porter, Crestmont Consolidated Corporation, Burbank, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

A three-axis solid-state missile autopilot, largely amenable to RCA micromodule packaging techniques, is described. Each axis channel consists of a summing network where the position and rate gyro signals are combined, an a-c amplifier, phase-sensitive demodulator, response-shaping network, and d-c current amplifier to furnish the differential signals to valve actuators. Position feedback from the actuators furnishes the focal loop for correct engine positioning. Roll control is effected via differential action of the vernier pitch engines. In addition, two optional types of solid-state programmers are described: One, a more or less conventional binary counter and matrix arrangement; the other, a novel magnetic technique. Each programmer has a 2000-sec capacity, and each is capable of initiating via solid-state switches up to 10 functions, such as selection of gyro torquing rates, gain change, and guidance control changeover.

A description also is included of a transformerless power supply capable of furnishing all autopilot voltages as well as crystal-controlled gyro spin-motor supply. A suggested package design is provided to emphasize the potential advantages of the assembly techniques, such as a ten-fold reduction in size and weight over the tube-type version now in use on the Thor missile program.

Application of Four-Pole Parameters to Torsional Vibration Problems..61—Av-8...By C. T. Molloy, Space Technology Laboratories, Los Angeles, Calif. 1961 ASME Aviation Conference paper (multilithographed; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Jan. 1, 1962).

The application of the method of four-pole parameters to torsional vibrations is discussed. Results are developed from fundamental principles. The four-pole parameters for the basic rotational elements are derived. These include shafts (both lumped and distributed-parameter cases), disks, dampers, and gears. The equations that must be obeyed when these elements are connected are presented. The application to construction of equivalent electrical circuits is given; in particular, a method for constructing the equivalent circuit of distributed-parameter systems is put forth. The torsional analogs of Thevenin's and

Norton's theorems are given for rotational sources.

These fundamentals are then applied to the following problems: (*a*) The effect of substituting one four-pole for another in a torsional system. (*b*) The effect of opening a four-pole system and inserting a new four-pole between the separated four poles. (*c*) Calculation of all the torques and angular velocities in a tandem system. (*d*) Calculation of natural frequencies of undamped four-pole systems.

Logistic Supply and Handling of Liquid Helium..61—Av-10... By John W. Marshall, Air Force Flight Test Center, Edwards Air Force Base, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The benefits of having liquid helium available from a national supply system are discussed. A perfected supply system will simplify support of strategic operations, reduce transportation costs, provide flexibility of distribution, and provide rapid world-wide delivery of helium in bulk quantities. To accomplish this objective, the paper is organized to provide a summary of related historical background, future supply, and uses for helium, a brief description of liquid-helium equipment developments to data, and the logistic and economic advantages of liquid-helium deliveries.

Integral Pressure-Vessel Welding Techniques—A Review..61—Av-14... By Leo E. Gatzek and Ivan Rattinger, Aerospace Corporation, El Segundo, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

Welding methods required for current and future integral pressure vessels are reviewed. Materials selected for liquid and solid-propellant tanks are listed, welding processes are discussed, and combinations of materials and techniques previously employed are set forth.

Production problems and means for inspection and nondestructive testing of the design are presented. Conclusions are drawn regarding the applicability of the present state-of-the-art to future integral pressure-vessel welding requirements. Areas in which suitable information is not available are noted and methods for providing this information are hypothesized.

Patterns of Failures on Guidance and Instrumentation Equipment..61—Av-15... By R. L. Horn, Boeing Airplane Company, Wichita, Kan. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

This paper is based on analyses of failures and failure patterns on the B-52 airplane. The information indicates that most failures are caused by infrequently failing parts. The impact of this fact on the standard practices of design and procurement of equipment is suggested. Implications of the changing failure rate within a mission are discussed and explanations are offered. Results of analyses directed toward determining the actual number of failures caused by maintenance are included.

Analysis and Solution of Vibration Problems in the Hughes Model 269A Helicopter..61—Av-19... By F. C. Strible, Hughes Tool Company, Culver City, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The Model 269A helicopter is an ultra light, two-place helicopter powered by a 180-hp Lycoming 0-360 horizontally opposed four-cylinder engine. The engine is suspended below the cockpit by four rubber shock mounts and drives a fully articulated three-blade main rotor and a two-blade teetering tail rotor. The helicopter was developed primarily for the U. S. Army in response to an Army requirement for a new light observation helicopter.

The drive system of the Model 269A helicopter is a unique combination of pulleys, V-belts, gears, and shafting. One of the primary advantages of this system is the exceptionally low vibration level that may be achieved when the system is properly designed to tune out responses to external forcing functions, such as the engine and rotors. However, because of many variables in the system, some of unknown magnitude, the optimum configuration is not amenable to accurate determination by analysis

Consequently, a combined analytical and experimental approach was used to exploit fully the potential of the system. This procedure, which was effective in obtaining optimum solutions to several resonant problems that developed during initial testing of the helicopter, is described in this paper.

On the Development of Launchers for Low-Acceleration, Multi-Nozzle Missiles..61—Av-20... By A. N. Baxter, Space Technology Laboratories, Inc., Los Angeles, Calif. 1962 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The test and analytical results described are one phase of the recent, highly successful Air Force program in which the Minuteman underground launcher was developed. The program objective was to obtain test data from a low-cost, easily modified scale model, which would provide the full-scale phase with optimum configurations. Tests were performed at the Missile Static Test Site, AFFTC, under the direction of the Ballistic Missiles Division and Space Technology Laboratories.

The hardware consisted of: (*a*) a transparent plastic cylinder that simulated the launcher tube, (*b*) a flame deflector at the closed end of the cylinder, and (*c*) the scaled-missile first stage. The program and hardware were arranged so that: (*a*) location and severity of maximum heating could be readily detected, (*b*) the data easily reduced, and (*c*) the tests would yield qualitative data, with quantitative information derived where possible. Thus usual types of transducers were not employed. Rather, low-cost "indicators" were developed. Data were obtained from these by high-frame-rate photography. Time and the location of the most severe heating, and "heating factors" were obtained during data reduction.

Test variables were: (*a*) missile axial, lateral, and angular position, (*b*) flame-deflector shape, and (*c*) launcher-duct diameter. Three basic deflector shapes were tested: the total cone; a flat plate; and a concave hemisphere. More than 200 tests were performed on 45 different deflector configurations. A concentric transparent "liner" was tested between the missile and the launcher wall.

Gust Alleviation in the Modern Airplane..61—Av-16... By G. M. Andrew and F. H. Gardner, North American Aviation, Inc., Downey, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The operation of airplanes at increased speeds in the presence of air turbulence is a detriment to smooth flight. As a remedy for this situation, systems have frequently been proposed to measure gust velocities and effect corrective action through the flight control system. Such systems are generally referred to as gust alleviators. This paper outlines the objectives and past history of gust alleviators. The results of various analytical and simulation studies are reviewed and interpreted in the light of the requirements for modern high-speed transport aircraft. Some general conclusions are drawn.

The Disciplined Geometry of Micro-Modules Yields Practical Miniaturization..61—Av-17... By J. W. Knoll, Radio Corporation of America, Camden, N. J. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

Primary planning and analysis of both equipment and system design must extend beyond consideration of a complex of parts and circuitry if practical miniaturization is to be realized. In the "disciplined geometry" of the micromodule a practical method is available

for expediting packaging design of any electronic system in which extreme compactness is a key consideration. This paper presents a brief description of the micromodule as a building block and the current status of the micromodule program in terms of both up-to-date hardware availability and contemplated applications.

Elevated Temperature Stress-Rupture and Fatigue Properties of Inconel and Inconel X in Ammonia Atmosphere..61—Av-21... By Mitchell H. Weisman, North American Aviation, Inc., Los Angeles, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The design of the X-15 research vehicle presented a number of unusual materials problems. Inconel X had been selected as the material for the outer skin and structural members of the vehicle, and both Inconel and Inconel X for the fabrication of the ammonia fuel tanks.

Inconel and Inconel X sheet materials, both parent metal and fusion butt-welded specimens, were tested in stress-rupture and fatigue in air and ammonia atmospheres at temperatures up to 1330 F. The ammonia atmosphere appeared to have a slight detrimental effect on the 1000 F stress-rupture life of Inconel welded to Inconel X. No other adverse effect of the ammonia atmosphere was noted. The data are discussed to show the effects of elevated temperature exposure time and testing speed on fatigue life.

Large Butterfly Valves in the Propulsion Wind-Tunnel Facility at Arnold Center.. 61—Av-22... By James C. McLane, Jr., Arnold Engineering Development Center, ARDC, U. S. Air Force, Arnold Air Force Station, Tenn. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

Modern aerodynamic wind tunnels present a wide variety of air-valving problems. Design criteria usually include such items as: (*a*) tight shutoff, (*b*) low permissible inleakage of atmospheric air or outleakage of process air, (*c*) low-pressure drop across the valve in the open position, (*d*) ability to throttle compressible fluids at or above critical pressure ratio, (*e*) wide range of operating pressures, (*f*) wide range of operating temperatures, (*g*) fast response rates and good control characteristics, (*h*) space and weight limitations, (*i*) ability to carry structural loads imposed by adjacent air ducts.

The butterfly valve, by virtue of its adaptability to such criteria combined with its relative simplicity and initial low cost, has found wide acceptance in these applications. The propulsion wind tunnel at Arnold Engineering Development Center, Tullahoma, Tenn., is unique in many respects. The application of large butterfly valves to its process system is typical, however. Fifty-five butterfly valves ranging in size from 16 to 216 in. ID are used in this facility as either "stop" valves for configuration changes or "control" valves to vary air flows and pressures within the complex. A brief description of this facility and its major subsystems is given for a general understanding of the function of these valves.

Optimization Procedures Applied to the Environmental Conditioning System for the B-70 Air Vehicle..61—Av-23... By Earl W. Adams, Hamilton Standard, division of United Aircraft Corporation, Windsor Locks, Conn. 1962 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

A portion of the optimization procedures that were developed for the derivation and design of the environmental conditioning system for the B-70 air vehicle included is a derivation of the basic simplified penalty equations used to determine equivalent take-off weight. The use of the optimization procedures as applied to the B-70 environmental conditioning system is illustrated by several examples.

The over-all optimization procedure is summarized as follows:

1 Design the heat exchangers for several values of transport liquid flow rate and effectiveness. In each design, optimize the pressure drops by balancing fixed weight against the equivalent weight of the power consumed. Determine the total equivalent fixed weight.

2 Determine the vapor-cycle power penalty for decreasing the evaporator temperature, and optimize the effectiveness of each heat exchanger by trading off heat-exchanger equivalent fixed weight against vapor-cycle power penalty.

3 Determine the optimum transport-line equivalent weight as a function of flow rate by minimizing the sum of fixed weight and power penalty.

4 Combine the optimized heat-exchanger weight penalties, the over-all vapor-cycle penalty, and the optimized line penalties for various flow rates, and select as optimum flow rate that which gives the lowest total equivalent fixed weight.

Norair Air Modulator Acoustic Generator..61—Av-24... By D. C. Skilling, Northrop Corporation, Hawthorne, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

Acoustic environment simulation studies performed by Norair Engineering Laboratories during 1958 and 1959 led to development of the present Norair air modulator acoustic generator. The air-modulator acoustic generator is a cross between the siren and the loudspeaker. It produces sound energy in the same manner as the siren, through modulation of high-pressure air flow by means of variable-area ports. In the siren, this modulation occurs at a periodic rate equal to the rotor speed times the number of ports in the rotor. Thus the generated sound can only be composed of a fundamental frequency plus its higher harmonics.

In the Norair air modulator, variation in port area is controlled by an electromagnetic driver similar to that of a loudspeaker. Thus the modulation rate need not be periodic but can be made to follow a complex, nonperiodic electrical signal.

This unit was designed to generate high-intensity acoustical energy with a broad-band frequency spectrum and a random energy distribution at all frequencies within the band. The paper describes this development.

Facility Design for Combined Environmental Testing of Rocket Propulsion Components..61—Av-25... By Robert J. Thoreson, Assoc. Mem. ASME, Air Force Flight Test Center, Edwards Air Force Base, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The author describes a valve-evaluation test facility utilized for combined environmental testing of rocket-propulsion components that is currently in operation at the Edwards Air Force Base Directorate of Rocket Propulsion. Described are fluid-conditioning systems comprised of specialized tanks, pumps, valves, and heat exchangers for liquid and gaseous oxygen and nitrogen, gaseous helium, and kerosene-type fuel. Systems for producing environmental extremes of temperature, altitude, humidity, and vibration are included. Experience acquired in this field is disseminated to enable an exchange of information in the hope that the facts presented will establish guide lines for future development in this field.

Missile System Elastomers—Predicting Field Life Expectancies..61—Av-26... By J. S. Chandler, Chrysler Corporation, Detroit, Mich. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The lack of a well-defined method for predicting field life expectancies of elastomeric parts in missile systems has caused problems in establishing accurate maintenance schedules. To alleviate this deficiency, a method has been developed and proved, by practical application, to

be adequate. This method has also proved equally effective for predicting life expectancies of parts other than elastomers.

Identified as the Engineering Evaluation Method, it has been used for more than a year; sufficient time to demonstrate its worth. It has been used successfully to establish maintenance cycles for two missile-weapons systems. Sponsors of other methods have added their support to the Engineering Evaluation Method, further establishing its superiority over other methods.

The Ling Model L-200 Vibration Exciter—A Breakthrough in Shaker Development ..61—Av-27... By John W. Schreiber, Ling Electronics, Anaheim, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

One of the most difficult problems in large shaker design, and for that matter in the design of any shaker, is to maintain a stiff moving armature structure having a high axial resonant frequency. At the same time, the armature must be as light as possible to permit the attainment of the highest possible unloaded G-levels. The conventional approaches to this problem involve the attaching of an armature winding to a supporting structure of some kind, and indeed these approaches (especially in the Ling 249 shaker) have yielded a highly successful design for many applications where testing is confined to frequencies below about 2000 cps.

A radically new development in vibration exciters is described in which the current-carrying conductors and the supporting structure for the exciter armature are one and the same. This design leads to numerous advantages, among the most important being a moving structure that is much lighter in weight and capable of operating at a much higher frequency than any existing design. In this paper the shaker is described in detail and curves of measured response are shown.

The Ling model vibration exciter. Basic design concept is that current-carrying conductors and supporting structure are one and the same (61—Av-27).

The Response of Uniformly Damped Cantilever Beams to a Random-In-Time Force ..61—Av-28... By G. W. Painter, Lockheed Aircraft Corporation, Burbank, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

Stress-response functions were determined experimentally for both lightly damped and highly damped cantilever beams using sinusoidal and random excitation.

The lightly damped beam was aluminum and had the dimensions of 24 in. × 2 in. × 0.08 in. The highly damped beam had dimensions of 18 in. × 2 in. × 0.138 in. It consisted of an 0.062-in-thick strip of aluminum coated with an 0.076-in. layer of Aquaplas. The beams were clamped at one end to a very rigid structure. Excitation was supplied electromagnetically through voice coils attached near the free ends.

Excellent agreement was obtained for the two methods of excitation. An Appendix is included to show the mean square stress that a given cantilever will experience when subjected to a random force of known power spectral density.

Stability of Honeycomb Sandwich Cylinders..61—Av-36... By Mehmet O. Kiciman and Don Y. Konishi, North American Aviation Inc., International Airport, Los Angeles, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The instability of a honeycomb-sandwich cylinder under axial compression, torsion, and external lateral pressure is discussed. The simply supported honeycomb-sandwich cylinder considered here has face sheets of equal thickness and an isotropic honeycomb core. Curves are presented for the cases of axial compression and lateral pressure only, as well as torsion only. The combined case is handled by means of interaction equations based on the curves shown.

Calculating Residual Stresses in Some Formed Parts..61—Av-38... By C. S. Yen, Douglas Aircraft Company, Inc., Santa Monica, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

In airframe manufacturing, structural sections are more often than not formed to shape before use. The forming operation always introduces residual stresses in the sections. These residual stresses may cause warpage during machining, and weaken the fatigue and corrosion resistance. To forestall these troubles, an evaluation of the residual stresses due to forming is necessary.

It is shown that the residual stresses due to room temperature forming of structural sections such as angles, tees, and channels can be predicted mathematically and verified experimentally. The forming can then be controlled to keep the residual tensile stresses below prescribed limits. The limited residual stresses in the parts result in greater fatigue strength and improved resistance to stress corrosion cracking. Because of these benefits, the structures are upgraded greatly. Residual stresses for several aluminum alloy 7075 sections formed at room temperature in different heat-treated conditions are presented.

An Integrated Cryogenic System for Spacecraft Power, Thrust, and Cooling.. 61—Av-39... By W. L. Burriss and J. L. Mason, AiResearch Manufacturing Division, The Garrett Corporation, Los Angeles, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The authors demonstrate the capabilities of hydrogen in integrated systems providing cooling, secondary power, and thrust for certain classes of space vehicle. The applications where hydrogen can be used to advantage are characterized by high heat loads, moderate secondary power, and low thrust requirements. Manned re-entry vehicles and recoverable boosters are examples of applications where substantial weight savings or improvements in vehicle mission capability can be effected.

It is found that cryogenic hydrogen systems providing power can be used to advantage in spacecraft for mission durations ranging from one hour to over one

hundred hours. By integration of the power, cooling, and attitude control requirements, the range of optimum application can be extended significantly.

The maximum duration for optimum application depends upon vehicle attitude control requirements and the ability to utilize the large total impulses, at low thrust levels, contained in the working fluid discharged from an open-cycle expansion power unit. For example, a 3-kw output oxygen-hydrogen expander operated at a BSPC of 1.12 lb per BHPHR will continuously provide 0.38 lb of thrust. If this can be used for attitude control purposes on a 50 per cent duty cycle, a system of this type will be optimum for durations up to 300 hr.

Ausform Steels, Ultra-High Strength Materials for Lightweight Rocket Casings..61—Av-40...By Stuart T. Ross, Aeronutronic, division of Ford Motor Company, Newport Beach, Calif. 1960 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The Ausform concept represents an advance in materials science that can act to close the gap between materials requirements and their capabilities. A thermomechanical treatment for steels, it is being developed as a method for producing solid-propellant rocket casings having strength-to-weight ratios in excess of 1,000,000 in-lb per lb.

Research basic to the process has been performed by the Ford Scientific Laboratory over a 5-year period. A patent based on this work was issued to Ford Motor Company in April, 1960. It concerns deformation of steels in the metastable austenitic condition. This process, as detailed in the paper, can upgrade the useful strength of many steel alloys, through imparting ductility at ultrahigh strength levels. Preliminary data are presented and their implication to rocket-casing design is discussed.

Mechanical Refrigeration for Lunar Systems..61—Av-29...By D. B. Mackay, North American Aviation, Inc., Downey, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

Some form of refrigeration will be required for inhabited lunar surface structures. Selection of fluids and refrigeration cycles for lunar operation are investigated. In analyzing the factors that cause actual cycles to deviate from the Carnot cycle, it is shown that the deviation due to throttling of the fluid can be predicted by use of a fluid parameter equal to the latent heat divided by the product of the liquid specific heat and the evaporation temperature. This parameter is therefore important in predicting the fluid performance.

Performance comparisons showing the size of the condenser and the compressor power are made for single and cascade machines operating in a variety of lunar environments and maintaining temperatures of 460, 500, and 540 R (0, 40, and 80 F) in the evaporator.

Explosive Metal Forming Comes of Age..61—Av-37...By G. C. Throner, Aerojet-General Corporation, Downey, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

In less than three years, explosive metalworking has progressed from a little-known laboratory curiosity to a standard production process. Primary emphasis is currently being placed on the production of explosively formed and sized components for large, solid-fuel rocket engines. Important advances are also being made in the development of explosive cutting, piercing, and swaging processes and in the application of high-explosive energies to the compaction of powdered metals. These processes are discussed briefly. No significant limitations have yet been encountered in either the size or type of metallic materials that can be worked by explosive processes.

Radiant Interaction Between Fin and Base Surfaces..61—Av-30...By E. M. Sparrow, Assoc. Mem. ASME, and E. R. G. Eckert, Mem. ASME, University of Minnesota, Minneapolis, Minn. 1961 ASME Aviation Conference paper (multilithographed; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Jan. 1, 1962).

Radiating surfaces have been widely recognized as an important means of disposing waste heat from space vehicles. In this connection, it has been natural to consider the use of fin surfaces to augment the radiation heat transfer, and the characteristics of radiating fins have been studied extensively. Much of this work has been carried out for simple, one-dimensional fins that do not radiatively interact with other fins of the ensemble or with the base surface to which the fin is attached.

Consideration is given to the effects of mutual irradiation occurring between a fin and its adjoining base surfaces. The first part of the analysis deals with black surfaces. It is found that in the range of practical operating conditions, the fin heat loss is significantly reduced by the presence of the base surfaces. Additionally, the base-surface heat loss may comprise an important part of the total heat loss from the system. In the second part of the paper, the formulation is extended to include selectively gray surfaces and arbitrary irradiation from external sources. This degree of generality leads to a complex mathematical system composed of several integral equations and a differential equation.

Thermal Stress in Circumferentially Constrained Thick-Walled Cylinders and Solid Spheres..61—Av-41...By Walter Unterberg, Rocketdyne, a division of North American Aviation, Inc., Canoga Park, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

In ceramics at high temperatures it is desirable to avoid tensile stresses because ceramics are weak in tension. However, ceramic fuel elements in nuclear reactors normally do encounter high tensile thermal stresses, especially at the cooled surfaces. This analysis investigates the effect of circumferential constraint in minimizing tensile thermal stresses in hollow cylinders and solid spheres.

The equations and graphs presented give radial and tangential thermal stresses in heat-generating cylinders and spheres for the extremes of zero and complete constraint. For both shapes, thermal stress profiles that include high tensions at zero constraint become entirely compressive at complete constraint.

The generalized solutions and particular results for uniform heat generation enable desired circumferential constraints to be selected and matched to the constraining structure for given temperature distribution, geometry, and material properties of the fuel element. Refinement of the assumptions and boundary conditions for a closer approach to the true physical picture constitutes useful additional work in this area. This should take into account factors such as inelastic material behavior, nonuniform constraint, exponential heat generation, and cooling fluid pressure.

Evaluation of the Short-Time Mechanical Properties of Structural Beryllium..61—Av-42...By Eugene C. Bernett, The Marquardt Corporation, Van Nuys, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

There are many structural applications today, especially in missile and other aerospace devices, in which weight is the critical factor. Although there are a number of major drawbacks with regard to using beryllium for structural components, it nevertheless is one of the lightest and stiffest metals.

An evaluation of the conventional and rapid rate tensile properties and the short-time high stress-creep properties was carried out at temperatures ranging from 75 to 1500 F. The material, test equipment, and test procedures are described in detail. The individual test results are listed in tables and these data have been analyzed and are presented in

graphical form suitable for design use. Where short times are involved, tensile data may be used at operating temperatures up to about 900 F. At higher temperatures, time-dependent strain becomes a critical factor and designs must be based on creep strength.

Aircraft Hydraulic Pumps and Motors—New Developments Presage Increased Utility and Application..61—Av-32... By F. L. Moncher and R. P. Lambeck, Vickers Incorporated, Detroit, Mich. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The explosive nature of breakthroughs in performance of aircraft and missiles has imposed rigorous demands on accessory systems, particularly those required for flight control and utility operations. Since hydraulics have shown peculiar advantages in these systems, the specifications for hydraulic components have become increasingly demanding.

This paper describes the development programs necessary to produce hydraulic pumps and motors that are compatible with the environments and performance requirements of modern airborne vehicles. Information on design and development activity on piston and vane-type pumps and motors is given, as well as fluid characteristics and test experience.

On Thermal Stresses in Cylinders Subjected to Gamma-Ray Heating..61—Av-34... By N. A. Weil, Armour Research Foundation, Chicago, Ill. 1961 ASME Aviation Conference paper (multilithographed; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Jan. 1, 1962).

Thermal stresses in cylinders, perfectly insulated on the outside and subjected to internal heat generation due to gamma-ray radiation, are considered. Numerical values for the governing stress are presented up to $q = 7$ and $Eta = 100$. The asymptotic values are indicated, which permits the treatment of any problem of practical interest. Three simplified solutions, containing only elementary functions, are evaluated. These approximations are found to be surprisingly accurate, at least one of them being of sufficient engineering accuracy over the entire range of variables.

Improvement of Fatigue Life of Aircraft Components by Coining..61—Av-35... By A. Phillips, Douglas Aircraft Company, Inc., Santa Monica, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

Coining, as discussed in this paper, is the addition of a concentric groove around a hole or other open configuration. A die or rolling wheel is used under pressure to form the groove. The formation of the groove causes displacement of metal toward the center of the opening. The metal adjacent to the opening is simply forced inwardly so much that it is usually necessary to ream out the hole to its original diameter if a fastener is to be inserted.

This paper presents in part the experimental data obtained in the development of this fabrication process. Essentially, coining produces compressive residual stress adjacent to holes, slots, or notched edges in a structural member. The introduction of this favorable residual stress at these high-stress points has increased the fatigue life and hence the service life of structural components in aircraft. Included is a general discussion of the critical relationships and variables in coining as well as monobloc and simple joint fatigue test data. This process has been used on DC-6, DC-7, and A3D airplanes and is currently being incorporated in countless applications on the DC-8.

Heat Transfer Applied to Space Storage of Cryogenic Propellants..61—Av-33... By Forrest R. Cleveland, Aerojet-General Corporation, Azusa, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The problem of storing cryogenic propellants in space is really nothing more than a specific example of the general thermal-control problem. Many of the considerations with which the designer is faced in a general satellite thermal-control problem quite naturally must also be faced in the design of a vessel for the space storage of cryogenic propellants. There are also many new and unique considerations that do not normally arise in general thermal control. Both problems are discussed.

The author points out the similarities and differences in the general problem of satellite thermal control and a specific example of this problem—the space storage of cryogenic propellants. Four major problem areas are discussed: (*a*) energy sources, (*b*) radiation properties, (*c*) protective insulation, and (*d*) storage time.

A Study of Limitations of Air-Breathing Thermal Engines..61—Av-45... By Claude A. Sarro, Grumman Aircraft Engineering Corporation, Bethpage, L. I., N. Y. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

Establishing the acceptable flight limits of air-breathing thermal engines is complicated by the changes in gas composition due to dissociation and recombination in the engine. This paper discusses these changes and the way they influence performance and flight limits of a representative air-breathing engine, the ramjet.

An IBM 704 computer was used to calculate the performance and the change in gas composition at each engine station for a given hydrocarbon fuel and for various flight conditions. Several values of inlet-pressure recovery, burner-drag coefficient, and burner area are investigated. A criterion for "quenching" of the flame at high altitude is presented. Pressure, temperature, and other thermodynamic parameters which define flight limits are calculated throughout the engine.

Development of a Small Gas-Turbine Engine for Helicopter Propulsion..61—Av-46... By P. W. Pichel, Solar Aircraft Company, San Diego, Calif., and J. V. Ryan, Gyrodyne Company of America, Inc., St. James, N. Y. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The Solar Titan T62 shaft-power gas-turbine engine has the distinction of being the smallest gas turbine developed under government sponsorship for propulsion of military aircraft. Initially rated at 55 hp and recently uprated to 60 hp (100 F, sea-level conditions), it weighs 54 lb, is 22 in. in length (from output-shaft flange to exhaust-duct flange), and has a maximum diameter of $12^1/_2$ in.

The Titan T62 gas-turbine engine was designed specifically for propulsion of the U. S. Navy's one-man helicopter. Simplicity of design is combined with unusual mechanical features demanded by the air-frame installation. Performance objectives were exceeded and the in-

Pumping cartridge of a subminiature vane pump (61—Av-32)

herent advantages of a turbine over a reciprocating engine for this application were demonstrated in a successful flight test program. Design, development, and initial flight evaluation of the engine are described.

A Composite Materials System for Re-Entry Vehicle Applications..61—Av-47... By E. D. Weisert, The Marquardt Corporation, Van Nuys, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962)

A composite materials system has been developed for applications such as severe aerodynamic heating. The system is based on the philosophy of utilizing a good insulator that is stable at high temperatures to protect a basic load-carrying structure. The zirconia-refractory metal system developed is capable of sustained exposures to temperatures in excess of 4000 F and has good high-temperature stability, thermal-shock resistance, and erosion resistance. The philosophy of approach and the materials system development is described, and properties of a typical system are reported.

Cavitation Characteristics of Tank Mounted, Centrifugal Type, Cryogenic Pumps..61—Av-43... By J. F. Di Stefano and J. O. Panosian, Borg-Warner Corporation, Bedford, Ohio. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

Cavitation performance of specially designed, tank-mounted, centrifugal pumps flowing various cryogenic liquids is presented. Cavitation performance under both static and dynamic boiling conditions are discussed. Cavitation parameters, according to Wislicenus, Gongwer, Banerian, and Ross are calculated for purposes of comparing order-of-magnitude differences.

It is concluded that inducer-impeller and all-inducer tank-mounted, centrifugal cryogenic pumps exhibit definite order-of-magnitude improvements in the commonly accepted cavitation parameters. These improvements are attributable to certain design features incorporated in tank-mounted centrifugal pumps as well as the thermodynamic properties of the cryogenic liquids considered, namely, hydrogen, oxygen, and nitrogen, and certain physical phenomena that obtain with tank-mounted centrifugal, cryogenic pumps.

High Temperature Alloys for Small Gas-Turbine Application..61—Av-44... By M. Kaufman, General Electric Company, West Lynn, Mass. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

Because of many problems inherent in scaling down large engines to small size it is vitally important to know the structure and behavior of alloys to be used in such applications. The paper is devoted to a description of the metallurgical nature of alloys so that a proper evaluation can be made of how these can best meet small engine requirements.

A review is given of alloys now available for use in components operating at 1500 F and over, their basic metallurgical structure is described, and their limitations and possible future course of development outlined. It is concluded that their application in small gas turbines is about five years away.

Vibration Analysis of Small Gas-Turbine Blades..61—Av-48... By Rudolph Hohenberg, AVCO Corporation, Stratford, Conn. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

During the development of gas-turbine engines, Lycoming conducts vibration investigations to determine the stresses on rotating compressor and turbine blades. These investigations include analytical studies, strain measurements on operating blades, and simulated vibration of larger than life-size models. Information derived from these investigations makes it possible to isolate the source of vibration and to define the maximum stress imposed on the blades and the location of this stress quickly and accurately. This paper describes the methods and techniques used at Lycoming for such an analysis.

Spin and Recovery Simulation of the NAA A3J-1 Airplane on the Human Centrifuge..61—Av-51... By Robert Z. Snyder, Aviation Medical Acceleration Laboratory, U. S. Naval Air Development Center, Johnsville, Pa. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The North American Aviation, Inc. (NAA) A3J-1 is a two-place, two-engine attack aircraft, designed for carrier-based operation, and capable of supersonic, high and low-altitude special weapon delivery. NAA is required to demonstrate the spin-recover capabilities of its A3J-1 airplane prior to its acceptance by the U. S. Navy. The pilot is required to allow five turns of spin before initiating recovery procedures. The spin recovery must then be accomplished within a maximum of six more spin turns. If recovery within the specified time is not possible, the pilot will attempt to recover, and failing this, will eject.

A significant fact is that the pilot is 28 ft from the center of rotation of the aircraft when it is in a spin. With such a large radius of rotation, it is anticipated that the pilot will be exposed to acceleration stresses as high as $-5.5\ G_z$.

Pilot ability to recover the aircraft while subjected to spin-type acceleration loads was evaluated by the Aviation Medical Acceleration Laboratory through the operation of the human centrifuge, so as to simulate an A3J-1 spin of eleven turns, with either steady or oscillatory loading during either normal or inverted spins. It was found that the pilots were capable of performing the required recovery procedures while exposed to the various predicted loads.

A Study of Rocket Vehicles Applied to Battlefield Logistics..61—Av-50... By S. A. Milliken and H. Nakamura, Assoc. Mem. ASME, Convair-San Diego, a division of General Dynamics Corporation, San Diego, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

Rocket vehicles which are used to transport military supplies will be called logistic rockets for the purpose of this paper. Logistic rockets can be pictured as guided or unguided rockets carrying supplies rather than warheads for payload. The recovery aspect of the payload is the only major difference between the missile and the logistic rocket. This aspect is similar to the delivery of supplies by conventional airdrop.

Ballistic rockets are the fastest means of delivery yet devised by man but one of the more expensive. The value of speed in transportation is not always appreciated because increased speed is almost always accompanied by higher cost. The objectives of this paper are to point out possible designs and applications of logistic rockets and to answer the question raised ten years ago by G. Gabrielli and Th. von Karman in an ASME paper entitled "What Price Speed?"

It is concluded that short-range logistic rocket requirements can probably best be fulfilled as an alternate requirement for tactical missiles, or to take the form of a multipurpose missile. Solid-fuel rocket motors appear to hold the greatest promise.

Long-range logistic rockets look promising provided the propellant is generated at the launch site. Liquid hydrogen and oxygen generation from sea water by means of nuclear power on seagoing tankers seems feasible. This, together with sea launching, offers the means for a long-range logistic-rocket system.

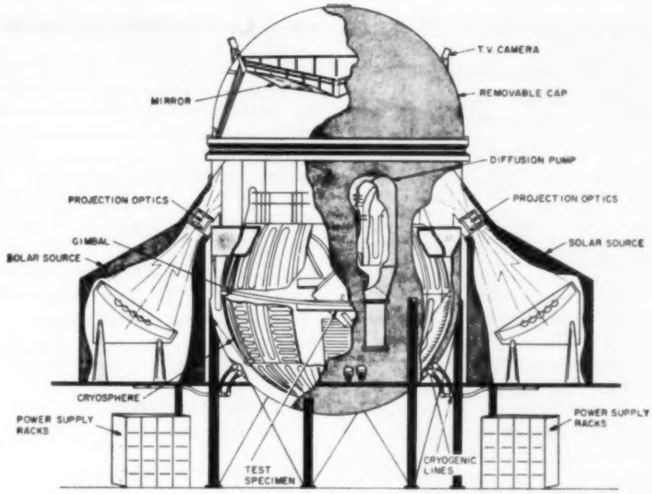
High-Strength Landing-Gear Forgings—The Manufacture of Ductile Components From Air Melted Steels..61—Av-54... By R. L. Roshong, Cameron Iron Works, Inc., Houston, Tex. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

Aircraft designers require high-strength, landing-gear components hav-

ing optimum transverse ductility to withstand the high shock and bending loads encountered in service. General industry practice has placed the ductility requirements substantially on the steel procedures with the forging supplier obligated to contribute little improvement. This tends to force the use of more expensive vacuum-melted steels.

Press-forging techniques have been developed to produce high-strength forging with outstanding transverse ductility from air-melted steels. Billet-stock properties are compared with forging properties for several landing-gear configurations and grades of steel. Low correlation between ductility of forgings and of billet is shown. A case is made for testing of forgings rather than billet stock.

A review of forging history is made to bring out several points. The most important of these is that the forging industry can make a real contribution toward the soundness and structural integrity of high-strength parts such as landing-gear forgings, and should not be considered primarily a method of providing a shape with a minimum of stock removal. A corollary to this point is that more expensive melting methods to produce a billet that will meet an arbitrary set of standards for billet qualification are not required when the forging industry performs its full function. Additionally, heats of material which failed to meet an arbitrary billet-qualification standard but which are otherwise judged to be of high quality need not be scrapped, thereby adding to the total cost of the over-all landing-gear program. Also, well-documented cases of successful forging histories should be able to reduce billet-testing programs and the eventual cost of the product.



Space environment simulator, designed to perform system tests on space vehicles. The simulator duplicates the sun's radiation. It is 54 ft long and 32 ft in diam (61—Av-52).

The Influence of Propellant Mass Fraction on Specific Impulse Requirements and Payload Capability of Chemical Rocket Propulsion Systems..61—Av-53... By I. S. Florman, Rocketdyne, a division of North American Aviation, Inc., Canoga, Park, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The dependence of specific impulse upon propellant mass fraction is derived in terms of ideal burnout velocity and payload fraction Z. From this equation, another relationship is developed which yields the trade-off between changes in specific impulse and propellant mass fraction. The latter relationship is shown to be independent of burnout velocity requirements but dependent upon payload fraction Z. Graphs are plotted to illustrate the effect of payload fraction and to serve as working curves in connection with the preliminary evaluation of propulsion systems relative to the foregoing.

Another equation is obtained relating propellant mass fraction to the payload fraction for various mission requirements when maintaining a constant propellant specific impulse. From this relationship, an equation is developed that is independent of ideal burnout velocity requirements and relates payload fraction Z, to propellant mass fraction X_p. Graphs are plotted to illustrate the effect of changes in propellant mass fraction on the changes required in payload fraction for a fixed set of conditions.

Discussion of the Design and Operation of the X-15 Environment Control System..61—Av-55... By D. G. Westbrook, North American Aviation, Inc., Los Angeles, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The design and the operation of the X-15 environment control system are described. In order to show the relationship of the environment control system to the over-all airplane, a short history of the project and an explanation of the airplane also is presented.

During the design and fabrication phases of the X-15 airplane, extensive laboratory testing was accomplished. It was expected that considerable laboratory work would be accomplished before a cryogenic material could be used successfully for temperature control. Several of the investigations pertinent to environment control included tests of a complete cabin and electronic-bay conditioning system mock-up, tests to verify the effectiveness of the insulation blankets, tests to determine the requirements for liquid-nitrogen cooling of the generators and the auxiliary power units, liquid-nitrogen evaporation rates from the storage tank, and tests of the flow characteristics of liquid-nitrogen flow through orifices and lines.

Design Criteria for a Space Environment Simulator..61—Av-52... By A. Lengyel, Assoc. Mem. ASME, and P. A. Marfone, General Electric Company, Philadelphia, Pa., and D. J. Santeler, General Electric Company, Schenectady, N. Y. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The design criteria for a space environment simulator are discussed. The space environment to be simulated and the test requirements for the experimental evaluation of space vehicles are described. The objective of establishing these design criteria is the design of an engineering tool for the development, demonstration of operational performance, product improvement, and reliability assurance for space vehicles. The three major requirements discussed are energy balance, solar radiation, and space vacuum effects on space vehicles.

Adverse Weather Systems for the Convair 880/990 Jet Transports..61—Av-49... By Dean T. Bowden, Convair-San Diego, a division of General Dynamics Corporation, San Diego, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

Wing, engine, and engine inlet anti-icing; empennage deicing; and windshield rain clearing systems are provided on the Convair 880 and 990 jet transports, to allow safe flight through natural icing conditions and rain of maximum severity. A summary of the selection, design, and development of the various systems is presented in this paper. New design and

constructional techniques used to attain high thermal efficiencies for the bleed air and electrical systems are described. A brief summary of flight tests conducted in natural icing is also presented.

Elastic Properties of Orthotropic Monofilament Laminates..61—Av-56...By J. C. Ekvall, Lockheed Aircraft Corporation, Burbank, Calif. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

To analyze the structural behavior of orthotropic monofilament laminates, it is necessary to know the elastic properties. In this paper equations are presented for determining the elastic properties of monofilament laminates based upon the properties of the filament and matrix materials. Equations are given for calculating the axial stiffness, shear stiffness, and Poisson's ratio in the principal directions for both undirectional and bidirectional laminates. The effects of the filament shape and spacing on the elastic properties are discussed. Test results for some music wire-epoxy resin laminates are presented which are in good agreement with the theory.

Development of the T63 Engine..61—Av-63...By John M. Wetzler and William S. Castle, Allison Division, GMC, Indianapolis, Ind. 1961 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1962).

The development of the T63 engine through its 50-hr preliminary flight rating test recently is the most recent milestone in the U. S. Army program to obtain a 250-hp aircraft gas-turbine engine. This paper presents the development story of the engine, dwelling on the problems peculiar to such a small gas turbine and pointing out its unique features.

The development of the T63 engine has gone through three distinct phases to reach the 50-hr preliminary flight rating test milestone. These were the concept-study configuration, the original running-engine configuration, and the 50-hr configuration. The authors comment briefly on each phase, then discuss the process of each main-engine component through the development program to the 50-hr test.

Some major problems encountered were: the compressor was $3^1/_2$ per cent low in air flow at the design point and was 7 per cent low in efficiency; the gasifier turbine, a single-stage unit, was also low in efficiency, about 14 per cent; mechanically the exhaust duct which served as the power-turbine bearing support was distorting badly, causing severe rub of the overhung two-stage power turbine.

Availability List of Unpublished ASME Papers

A NUMBER of papers and reports, not preprinted or published, were presented at ASME Meetings. Manuscript copies of these papers are on file for reference purposes in the Engineering Societies Library, 29 West 39th Street, New York 18, N. Y. Photostatic copies of these unpublished papers may be secured from the Library at the rate of 50 cents per page. Microfilm copies are available at a cost of $2 for 40 pages or less.

The following papers recently have been placed on file in the Engineering Societies Library:

1960 Power Conference

Steam Generator Design for Spinning Reserve, by C. F. Hawley

Heat Rate Isn't Everything, by J. H. Harlow

1960 ASME-AIME Fuels Conference

The Comparison of Sulfur Analyses by Combustion Tube and Eschka Methods Using Coals From Various Seams and of Varying Sulfur Content, by E. J. Sandy

1960 Winter Annual Meeting

The General Electric Transonic Cascade Tunnel, by J. R. Erwin and B. K. Genetti

A New Look at an Old Course—The Principles of Machine Design, by A. H. Burr

Whither ASME? by W. L. Cisler

1961 Gas Turbine Power Conference

The Air Force Role in the Development of Turbines, by J. R. Holzapple

The U. S. Army's Gas Turbine Program, by G. W. Power

Hot Stretching Gas Turbine Wheels, by B. O. Buckland and Coda H. T. Pan

Industrial Power Requirements and the Pratt & Whitney Aircraft Gas Turbine Engines, by W. J. Closs

Gas Turbine Mechanical Design Features, by T. J. Rahaim

1961 Aviation Conference

Development of a High Powered Solar Mechanical Engine, by B. T. Macauley

1961 American Power Conference

Supercritical Boiler Operating Experience at Avon, No. 8, by J. I. Argersinger and G. C. Smith

Avon Superpressure Steam Turbine Generator Unit, by C. C. Franck and J. A. Carlson

Liberation of Pyrite From Steam Coals, by R. A. Glenn and R. D. Harris

Initial Operation of Avon #8, a Supercritical Plant, by N. F. Gill and N. D. Flack

Second Progress Report on High-Speed Boiler Feed Pumps, by I. J. Karassik and E. F. Wright

Philadelphia Electric Company Multistage Flash Evaporator, by M. Liss, C. Caprara, E. F. Stalcup, W. B. Willsey, and D. Cane

Corrosion and Vibration in Mechanical Drive Steam Turbines, by S. Neal and W. J. Caruso

The Effect of Pulverizer Design on Furnace Performance, by H. M. Rayner and P. Seibold

Development and Operation of Fluid Drives for Turbine-Generator Driven Boiler Feed Pumps, by R. D. O'Neil

Observations and Experiences Resulting From a Precipitator Improvement Program, by M. J. Archbold

Coal Properties as Related to the Corrosion of High Temperature Boiler Surfaces, by J. T. Reese, J. Jonakin, and K. G. Koopman

The Breed Plant of the Indiana and Michigan Electric Company of American Electric Power Company System, by P. Sporn and S. N. Fiala

ASME TRANSACTIONS

Journal of Basic Engineering

The June, 1961, issue of the Transactions of the ASME—*Journal of Basic Engineering* (available at $1.50 per copy to ASME Members, $3 to nonmembers)—contains the following:

- Lubrication at High Temperatures With Vapor-Deposited Surface Coatings, by D. J. Baldwin and G. W. Rowe. (60—Lub-4)
- Perturbation Solutions for Gas-Lubricating Films, by W. A. Gross and E. C. Zachmanoglou. (60—Lub-13)
- Solution of Reynolds Equation for Arbitrarily Loaded Journal Bearings, by O. Pinkus. (60—Lub-3)
- Grease Lubrication Studies With Plain Journal Bearings, by L. J. Bradford, E. M. Barber, and J. R. Muenger. (60—Lub-5)
- The Volume of Stressed Material Involved in the Rolling of a Ball, by R. C. Drutowski. (60—Lub-7)
- Performance of Elastic, Centrally Pivoted, Sector, Thrust-Bearing Pads—Part I, by B. Sternlicht, J. C. Reid, Jr., and E. B. Arwas. (60—Lub-10)
- The Effect of the Method of Compensation on Hydrostatic Bearing Stiffness, by S. B. Malanoski and A. M. Loeb. (60—Lub-12)
- An Improved Analytical Solution for Self-Acting, Gas-Lubricated Journal Bearings of Finite Length, by J. S. Ausman. (60—Lub-9)
- An Assessment of the Value of Theory in Predicting Gas-Bearing Performance, by S. Cooper. (60—Lub-2)
- A Theoretical Investigation of Pressure Depression in Externally Pressurized Gas-Lu-

bricated Circular Thrust Bearings, by Haruo Mori. (60—Lub-6)

Extension of the Conducting Sheet Analogy to Externally Pressurized Gas Bearings, by L. Licht. (60—Lub-1)

Theory of Lubrication and Failure of Rolling Contacts, by B. Sternlicht, P. Lewis, and P. Flynn. (60—WA-286)

Inertia Effects in Hydrostatic Thrust Bearings, by D. Dowson. (60—WA-315)

Air-Hammer Instability in Pressurized-Journal Gas Bearings, by Lazar Licht. (60—WA-10)

On the Dynamics of Steam Liquid Heat Exchangers, by Arvid Hempel. (60—WA-110)

Dynamic Behavior of a Simple Pneumatic Pressure Reducer, by D. H. Tsai and E. C. Cassidy. (60—WA-186)

Transfer-Function Derivation and Verification for a Toric Variable-Speed Drive, by J. L. Harned, P. Sudhindranath, K. M. Miller, and R. J. Roddy. (60—WA-184)

Experimental Investigation of Corners in the Yield Surface, by Aris Phillips and G. A. Gray. (60—WA-7)

Expansion Coefficients for Orifice Meters in Pipes Less Than One Inch in Diameter, by G. A. Marxman and H. Burlage, Jr. (60—WA-137)

Flow Measurement for Accounting Purposes, by D. D. Livingstone. (60—WA-141)

Gas-Tracer Method of Steady and Pulsating-Flow Measurement, by J. F. Kemp. (60—WA-142)

Technical Briefs

Oil Flow in a Full Journal Bearing, by D. F. Hays

Potential Flow Analysis of Axial Compressor Cascade Aerodynamics, by J. Polášek

The Influence of Elevated Temperature on the Strength of Expanded Tube Joints, by I. Finnie.

Journal of Applied Mechanics

The June, 1961, issue of the Transactions of the ASME—*Journal of Applied Mechanics* (available at $1.50 per copy to ASME Members, $3 to nonmembers)—contains the following:

Technical Papers

On the Probability Densities of the Output of Some Random Systems, by Frank Kozin. (60—WA-18)

Transient Capillary Rise in Reduced and Zero-Gravity Fields, by Robert Siegel. (60—WA-201)

Minimum Transfer Time for a Power-Limited Rocket, by George Leitmann. (61—APM-6)

Adiabatic Analysis of Elastic, Centrally Pivoted, Sector, Thrust-Bearing Pads, by B. Sternlight, G. K. Carter, and E. B. Arwas. (60—WA-104)

The Effect of a Longitudinal Gravitational Field on the Supercavitating Flow Over a Wedge, by A. J. Acosta. (61—APM-2)

On Transient Thermal Stresses in Viscoelastic Materials With Temperature-Dependent Properties, by Rokuro Muki and Eli Sternberg. (60—WA-124)

Thermodynamic Analysis of the Darcy Law, by R. G. Mokadam. (61—APM-5)

A Bifurcation Phenomenon of Static Friction, by F. F. Ling and R. S. Weiner. (61—APM-7)

Propagations of Elastic Waves Generated by Dynamical Loads on a Circular Cavity, by A. C. Eringen. (61—APM-12)

On Classical Plate Theory and Wave Propagation, by M. A. Medick. (61—APM-3)

Extensional Vibrations of Elastic Orthotropic Spherical Shells, by W. H. Hoppmann II and W. E. Baker. (61—APM-14)

Experiments on the Postbuckling Behavior of Square Plates Loaded in Edge Compression, by Noboru Yamaki. (60—WA-103)

Stress Distribution on the Boundary of a Circular Hole in a Large Plate During Passage of a Stress Pulse of Long Duration, by A. J. Durelli and W. F. Riley. (61—APM-4)

On the Aeroelastic Instability of Bluff Cylinders, by G. V. Parkinson and N. P. H. Brooks. (61—APM-8)

A Modification of the Coulomb-Mohr Theory of Fracture, by Burton Paul. (60—WA-31)

The Effect of Shear and Normal Forces on the Fully Plastic Moment of a Beam of Rectangular Cross Section, by B. G. Neal. (60—WA-102)

On Normal Vibrations of a General Class of Nonlinear Dual-Mode Systems, by R. M. Rosenberg.

Uniqueness in the Optimum Design of Structures, by T. C. Hu and R. T. Shield. (61—APM-1)

The Bending, Buckling, and Flexural Vibration of Simply Supported Polygonal Plates by Point-Matching, by H. D. Conway. (60—WA-38)

Design Data and Methods

Design of Thin-Walled Torispherical and Toriconical Pressure-Vessel Heads, by R. T. Shield and D. C. Drucker.

Hydrodynamic Lubrication of a Roller Bearing—Introduction of Parameters to Obtain Charts for Calculation, by F. W. v. Hackewitz.

Brief Notes

Surface Waves in an Elastic Half Space, by C. C. Chao, H. H. Bleich, and J. Sackman.

Extension of Nadai's Sand Hill Analogy to Multiply Connected Cross Sections, by M. E. Gurtin.

Three - Dimensional Flow About Yawed Cylinders, by D. Benenson.

Vibrations of Thin Rectangular Isotropic Plates, by R. W. Claassen and C. J. Thorne.

Frequencies of Vibration of Shallow Spherical Shells, by W. H. Hoppmann II.

A Formula for the Torsional Stiffness of Rectangular Sandwich Plates, by Shun Cheng.

The Bailey Flow Rule and Associated Yield Surface, by E. A. Davis.

Application of the Heat Balance Integral to Problems of Cylindrical Geometry, by T. J. Lardner and F. V. Pohle.

Discussion

Discussion of previously published papers by Ho Chong Lee; W. W. Short, R. A. S. Brown, and B. H. Sage; W. H. Chu and H. N. Abramson; L. S. Han; H. D. Conway; Leslie Lackman and Joseph Penzien.

Book Reviews

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61—Av-20	61—Av-39	61—Av-69
	61—Av-40	

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COMMENTS ON PAPERS

System Expansion—Fuel Costs Versus Capital Charges

Comment by Constantine W. Bary[1]

The authors[2] have made a valuable contribution to the newly growing literature on the important subject of economic planning of utility-generating capacity. They have clearly described some of the fundamental aspects of a comprehensive study which has been made on The Detroit Edison system by employing computer programs involving simplified averaging techniques which they believe provide answers within the degree of accuracy required. It was gratifying to learn from their paper that the results of their "long-range generation plan" study lead them to conclusions which are in line with those we obtained, under a different technique, in our similar study, the results of which were reported in my paper.[3]

The authors' capital charge program appears to me to be comprehensive, flexible, and precise. As to their fuel-cost program, while I fully realize that different objectives can usually justify different techniques, I offer the following observations pertaining to the one used by them:

1 *Capacity-Factor Curve (Fig. 1)*—This is an historical curve, and in effect combines a load-occurrence curve, unit-outage data, and the effects of incremental loading. While the use of such a curve may be satisfactory when dealing with a series of units all of which have similar "load block-heat rate" characteristics, it seems to me that its application to units where these characteristics are dissimilar could introduce inaccuracies of significant magnitude.

2 *Average Load Versus Capacity-Factor Curve (Fig. 2)*—Although studies of the nature described in the paper generally depend on some historical data, such as, for example, average unit availability, or the manner of load occurrence, the authors' technique depends also on history repeating itself with respect to many items which are expressed as a function of capacity factor. It is quite probable that past performance will not be repeated in the future in those expansion programs which involve types of capacity for which no history has been recorded. For example, we already know that some new types of peak-shaving equipment run either at full load or not at all. Thus the historic curve data of average load versus capacity factor could not be applicable in the future to such new equipment.

3 *Full-Load Design Heat-Rate and Heat-Rate Multiplier Curves (Fig. 3)*—The determination of fuel consumption by the use of the design heat rate at full load and of heat-rate multipliers assumes that there is a definite relationship between the loading pattern of a unit and its capacity factor. Such is not the case under all conditions, particularly in the case of those peaking units which are not operated at partial loads. The technique employed in the paper represents a shortcut, and may conceal significant differences between varying types of equipment. It seems to me that these differences would be revealed more effectively through the use of fuel and operating-cost formulas, such as set forth in Table 2 of my paper,[3] which comprise the so-called "fixed," "capacity," "peak-prepared-for," and "energy" components of the operating costs of units, the latter two by specified load blocks.

4 *Operation and Maintenance Costs*—The paper gives the impression of the authors' belief that the operation and maintenance costs of two alternate programs usually do not differ too much. It has been our practice to examine these costs closely to determine if their inclusion would affect the comparison. This is particularly true when evaluating the economies of units of varying types. We have found from lengthy experience that even small differences in these costs can be determined by using cost formulas, such as reflected in Table 2 of my paper.[3]

5 *Start-up Costs*—The paper states that unit start-up costs have been neglected. I assume that this does not mean peak-prepared-for costs. Neglecting these costs could penalize certain types of equipment which are capable of rapid starts, or whose no-load fuel requirements are low.

I believe some worth-while refinements to the authors' approach can be obtained with little sacrifice of computer memory space, but at a somewhat extended computation time. If the latter is not a limiting factor, it appears to me that such refinements are warranted, especially in studies where the economic advantage of one plan over another depends on a difference between two large numbers. An error of relatively small magnitude in either or both of the large numbers can result in a considerable error in their difference. There are three major areas in which refinements can be obtained. These are: (*a*) Computation of fuel costs by components, i.e., fixed, capacity, peak-prepared-for, and energy; (*b*) consideration of operating costs, other than fuel, in the same manner; and (*c*) computation of incremental energy costs by load blocks of units, rather than by whole units. In this regard, AIEE papers CP 57-1066 and CP 58-1087 by Philadelphia Electric Company engineers may be of considerable interest.

[1] Director, Economic and Rate Analysis, Philadelphia Electric Company, Philadelphia, Pa.

[2] W. J. Fahrner and C. M. Heidel, "Power Plants—Tomorrow: System Expansion—Fuel Costs Versus Capital Charges," Mechanical Engineering, vol. 82, November, 1960, pp. 64-67.

[3] Constantine W. Bary, "Decentralized Peak-Shaving—Its Economic Significance to Electric Utilities," *Transactions ASME*, Series A, *Journal of Engineering for Power*, vol. 83, 1961, pp. 119-129.

Comment by C. H. Hoffman[4]

The availability of high-speed digital computers as a tool for power-system planning has stimulated much interest among electrical engineers. Papers describing computerized planning studies

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have appeared in the *AIEE Transactions* for at least five years [1–3].[5]

It was the vastly increased capability of the newer computers that motivated us to undertake jointly with engineers of Westinghouse Electric Corporation a rather comprehensive planning study using the technique of operational gaming [4]. Our approach was to develop a series of mathematical models which: (*a*) Simulate day by day for 20 years the margin between generator capacity and load [5]; (*b*) from the monthly statistical properties of these daily margins, determine the installation dates of future units; (*c*) calculate production expenses month by month [6]; (*d*) determine all transmission requirements [7]; and (*e*) compile the resulting revenue requirements on a present-worth basis. By comparing the present worth of future revenue requirements for various alternate patterns, an optimum pattern can be selected. Study results in the areas of unit size, reliability, and service level have been presented [8]. Results in the areas of peaking capacity and generator retirements await publication. Other uses of the models are in progress.

While our models are coded for an IBM 704, much useful planning information can be obtained with a medium-sized computer. The authors' paper[2] illustrates this point. The authors and their associates are indeed to be congratulated for exploiting so fully the capability of the IBM 650. The ability to extend the study for 35 years into the future is a particularly valuable feature. As the authors clearly point out, the advantage of this is not so much interest in the specific details of the later years, but rather the ability to use in short-range studies the program background of the 35-year optimum system.

By combining the present worth of annual system-fuel costs with the present worth of annual "fixed charges," the authors calculate a quantity we would call present worth of future revenue requirements. The authors' calculations cover only the span of the study, usually 35 years. This has the disadvantage of not fully weighing the consequences of decisions made in the later years. We prefer, for this reason, to use present worth of all future revenue requirements (PWAFRR), which are readily calculated to eternity [9]. As study periods grow longer, however, the two methods tend to give the same answer. Since the PWAFRR is an excellent measure of the relative economics of alternate plans, it is not clear why any conversion to level annual cost is necessary, or how this is done. A clarification would be welcome.

[5] Numbers in brackets designate References at end of paper.

The key to the authors' calculation of fuel costs is the capacity-factor curve of Fig. I. Surely the extrapolation of this curve to future years, with perhaps a radically different mix of generator units and different system-load characteristics must be done circumspectly.

The authors infer that the installation dates of future units are based on maintaining a fixed per cent installed reserve. This assumption is an open question in some studies. For example, in a comparison of a pattern using large units with one using small units, the large unit pattern requires a somewhat higher minimum installed reserve to provide the same level of service to the customer. Perhaps allowance for this fact is made in the input data.

The authors' omission of transmission requirements from the economic comparison is an important simplification. In our studies, although the cost of transmission facilities is relatively small (about 7 per cent), omitting the transmission component distorts the true answer. Table 1 shows an example of a peaking study in which including transmission costs reduces the optimum saturation from 15 per cent to 5 per cent. Note that the effect of including the transmission is not only significant, but also is in the opposite direction to what might be expected.

The goal that we all are working toward is the development of completely dependable tools to assist management in making correct planning decisions in all areas, not merely in questions relating to generation planning. The procedure described in this paper is a useful step in the right direction.

Table 1 (PWAFRR in millions of dollars)

Peaking	0 per cent	5 per cent	10 per cent	15 per cent
Production	1988	2010	2018	2035
Generation	1392	1343	1325	1305
Subtotal	3380	3353	3343	3340
Transmission	229	235	251	253
Total	3609	3588	3594	3593

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9 P. H. Jeynes and L. Van Nimwegen, "The Criterion of Economic Choice," *AIEE Transactions*, vol. 77, 1958, pp. 606–632.

Comment by T. J. Whelan[6]

The authors have presented in this paper[2] a method which has been employed to analyze and average historical data to arrive at a basis for predicting the annual capacity factors and average annual heat rates of future units. This would appear to be the major development which has permitted the programming of generation-planning studies on the limited storage-type IBM 650 computer.

Fig. 1, which determines the unit annual capacity factors, indicates that the system being considered has an annual capacity factor of about 53 per cent. The use of this curve, which is based on historical data, would infer not only that the annual capacity factor is assumed to remain at this level but also that the relationship of the system peak load to the average system load will also remain constant for the period of the study which may extend up to 35 years. Although there may be considerable uncertainty as to how system-capacity factors will vary in the future, there would appear to be equal uncertainty that they would remain at about the same level. Industry statistics published in 1958 indicated that the national average annual capacity factor varied from 44 per cent in 1941 to 59 per cent in 1956. It would appear advisable to arrange the program so that the shape of this curve could be varied so as to determine the effect of possible changes in the system-load characteristics.

Fig. 2, which shows average load as a function of capacity factor, is combined with turbine manufacturer's heat rate versus load data to develop Fig. 3 which is then used to correct unit-design heat rates

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for partial load. This method, in effect, determines the heat rate at average load and then uses it as the average heat rate. This assumption would appear to be reasonable when considering unit loads from 60 to 100 per cent since this portion of the heat rate versus load curve is relatively straight. It would appear, however, that in the area below 60 per cent load, or 40 per cent capacity factor in Fig. 3, that an error of several percentage points could be introduced by the assumption that heat rate at average load is equal to the average heat rate. For instance, for a unit having a 30 per cent capacity factor, average load would be 50 per cent and the partial load correction would be 1.03 (small last stage area). However, if the average load of 50 per cent is actually comprised of 25 per cent load and 75 per cent load operation, the respective correction factors would be 1.140 and 0.995 and the average would be 1.07.

In connection with Fig. 2 and 3 also, it is mentioned that Fig. 2 is combined with the turbine manufacturer's heat rate versus load data to develop Fig. 3. It would seem that station-heat-balance data would have to be used in this case in order to include the effects of such factors as changes in boiler efficiency, reduced main and reheat-steam temperatures and changes, percentagewise, in auxiliary power requirements.

With regard to the shape of the curves shown in Fig. 3, particularly in the area between 40 per cent and 100 per cent capacity factor, we have found that in most cases when station-heat-balance data and a constant circulating water temperature are used, the shape of the heat rate versus load curve is somewhat flatter than indicated in Fig. 3. This is due to the fact that increases in boiler efficiency and decreases in turbine-exhaust pressure tend to offset decreases in turbine efficiency and increases, percentagewise, in auxiliary power requirements.

In many studies of this type, it is not unusual to assume (1) that the differences in heat rate between full load and approximately 50 per cent load are not appreciable and are within the accuracy of other assumptions which must be made, and (2) that the error introduced by neglecting the correction at less than 50 per cent load is diminished by the fact that the number of kwhr is small and they occur primarily late in the life of the unit so that the present-worth correction is appreciable.

In view of the afore-mentioned, it would be of interest to know if the authors have had occasion to run one of these generation-expansion-plan studies without utilizing the heat-rate-correction data from Fig. 3 and what effect it may have had on the results.

Fig. 4, which shows an example of a fuel-program print-out data sheet, indicates how the computer ranks the various units in the order of ascending heat rate at their average load. An analysis of this data sheet would indicate that the variation in fuel costs for the various units is not taken into account. For instance, Unit No. 45 is ranked ninth with a heat rate of 8826 Btu per kwhr and a fuel cost of 40.93 cents per million, while Unit No. 13 is ranked tenth with a heat rate of 8841, 0.17 per cent poorer than Unit No. 45, but with a fuel cost of 40.28 cents per million which is 1.6 per cent lower than Unit No. 45. This same situation seems to appear also in the case of the units rank 17 and 18, where the unit ranked 18 has a heat rate 2.3 per cent higher, but a fuel cost 3.7 per cent lower than the unit ranked 17. It would seem that the ranking of units should be based not only on heat rate but also on relative fuel costs.

In the Table of Definitions, very-high-efficiency equipment with 8300 Btu per kwhr heat rate is assumed to have a plant cost of $152 per kw and high-efficiency equipment with a 9000 Btu per kwhr heat rate is assumed to have a plant cost of $145 per kw. These figures are of particular interest in that with a gain in heat rate of 700 Btu per kwhr available for an additional investment of only $7 per kw, the additional cost of very-high-efficiency units, which would comprise supercritical-pressure double-reheat units, would be offset by fuel savings in studies using an average annual capacity factor of 60 per cent, a fixed charge rate of 15 per cent, and a fuel cost of 29 cents per MM Btu. This difference of $7 per kw would, therefore, appear to be somewhat optimistic.

In summary, it appears that the authors have developed a program to take advantage not of the accuracy of the digital computer since the input data are all based on assumptions as to what conditions may be many years hence, but of the speed of the computer which will permit many studies to be made in a reasonable time, using varying assumptions, so as to determine the effect on the results of changes in the assumptions which must be made regarding future conditions.

Comment by B. L. Lloyd and K. M. Dale[7]

This is an excellent paper[2] on the application of a medium-scale digital computer to the evaluation of long-range generation-expansion patterns.

Utility management is primarily faced with deciding the size, type, heat rate, and other characteristics of the next one or possibly two units. They have a reasonably good idea of the date when the next unit will have to be in service. The question might be raised "Why try to plan for more than a few years ahead?"

The authors have recognized the necessity for carefully considering the effect of these short-range decisions on the long-range economic future of their company. The emergence of special purpose peaking plants and the imminence of economic nuclear plants further emphasize the necessity for good long-range planning. More and more utilities are adopting similar techniques for their day-to-day planning decisions.

Our company has worked with several utilities in the development of similar powercasting programs for large-scale computers (IBM 704 and IBM 7090). It may be of interest to indicate how these programs differ from that described in the paper.

The first difference is the greater scope of the large-scale programs since the transmission system is planned along with generation. Second is the greater detail made possible by the larger computer including allowance for outage of individual units, optimal maintenance scheduling, more accurate production costing, and so on. This increases the flexibility of the program since it can be used for installed reserve studies, spinning reserve studies, sizing transmission-interconnection requirements, and many others. Another difference is the determination of installation dates for new units based on probability of load loss. Flexibility plus higher computing speed makes it practical to evaluate decisions in the presence of many possible ways that future loads and costs may unfold. This permits a reasonable approach to not only accounting for future events but recognizing that the future events are uncertain.

We want to express our compliments to the authors for a timely and well-written paper. And we would like to encourage them to continue publication of their results as their work proceeds.

Comment by C. D. Galloway[8] **and W. D. Marsh**[9]

The authors of this paper[2] obviously

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[9] Application engineer, Electric Utility Engineering, General Electric Company, Schenectady, N. Y. Mem. ASME.

have taken considerable care to insure that their method of analysis considers the many factors which must be taken into account when formulating a system-planning program. The program which they describe is, in the opinion of the discussers, as detailed and comprehensive as any that could be written for regular use on a medium-sized computer.

It is noted that past history, in the form of the capacity-factor curve of Fig. 1, is extrapolated into assumed future conditions. Something of this sort is necessary, of course, in order to determine future unit loadings. Perhaps it would be possible, however, to modify the shape of the capacity-factor curve to reflect more completely the changes in system loading occasioned by nonhistorical expansion patterns such as the use of peaking units.

The determinations and redetermination of unit rank with application of the heat-rate-correction factor could become oscillatory, as noted in the authors' bibliographical reference. Has this situation presented any serious problems in the practical use of the program?

We concur with the authors' conclusion that start-up costs, as such, do not seem to differ enough from one expansion to another to warrant attaching much importance to them. The importance of a unit starting up is that it alters the loading of all machines in the system. This effect seems to outweigh by far the actual costs of the start-up itself.

The results given in the paper of preliminary studies are valuable to those who may be engaged in similar investigations. Of particular interest are the statements that approximately ten per cent peaking capacity may be economic on the future Edison system, and that the addition of peaking results in a substantial increase in annual capacity factor for the proposed high-efficiency machines which ultimately could lead to justifying further advances in steam conditions.

It is this kind of investigation and presentation of results that can be invaluable in pointing the direction for future development of the whole industry.

The authors' are to be congratulated and it can be hoped that this paper will encourage others to examine critically the important problem of system-expansion planning.

Authors' Closure

The authors would like to thank again the discussers for preparing these discussions and for attending the meeting to present them. Several of the comments have been useful in pointing up areas where changes in the program should be made.

In general, the discussers directed their comment toward certain specific areas of the program. It will be our purpose in this summary to offer certain additional information where we feel misinterpretation of the program is evident.

Capacity Factor Curve. Several of the discussers expressed themselves to the point that use of a fixed curve for extended period studies will produce inaccurate results. The authors agree that use of such a curve must be tempered by the engineer's estimate of the future system characteristics.

The curve used in this program can be changed to represent a different load factor and a different balance of unit types than presently exists in The Detroit Edison Company system. The fixed nature of this capacity factor curve is not unique to this program. The more detailed daily load dispatch programs which have been written depend on the shape of the daily load curves which the program planners assume. It is obvious that the shape of the daily load curves will vary over the years and that the ratio of peaks to valleys also will change. Adjustment in the shape of these curves depends on a certain amount of speculation on the part of the engineer.

This also is true of The Detroit Edison Company program; the engineer must judge what the shape of the yearly capacity factor curve will be. This being done the programmed curve is easily changed.

Partial Load Heat Rate Correction Factors. It is important to note that partial load heat rate corrections are not made for decentralized peaking units such as diesel generators and gas turbines.

These units are programmed to operate at full load; thus the correction factors are blocked out in the program. The partial load heat rate multipliers are useful when analyzing new unit types which have different partial load characteristics. In addition, with large percentages of decentralized peaking capacity the inefficient units in the system will operate at higher loads than they would if no peaking capacity were installed. The higher loading on these machines therefore will be reflected in a lower operating heat rate for these units.

Operation and Maintenance Costs. The authors agree that in any economic study of this nature operation and maintenance costs may be significant and thus cannot be ignored. These costs, however, are analyzed outside the scope of the computer program.

Present Worth Arithmetic. It was indicated by one discusser that this calculation would be more accurate if the present worth of all future revenue requirements extending to infinity were calculated. We have found that this approach only magnifies the difference between two schemes. If significant differences are generated in a shorter period of time (20 years) then a decision can be made which does not depend on what happens after that period.

The same discusser questioned the need for converting the present worth of future revenue requirements to a level annual cost. The advantage of converting to a level annual cost is to provide answers to management which are of reasonable magnitude. The present worth of the future system fuel cost for a 35-year program may be $700 million, whereas, the level annual cost is in the order of $50 million. The present worth difference between two schemes may be 70 million whereas, the level annual difference is $5 million. The level annual cost is determined by multiplying the present worth of all future revenue requirements by the appropriate capital recovery factor.

System Reserve. The minimum system reserve is determined by probability mathematics outside the scope of this program. This reserve obviously depends on the size and number of units in the Michigan Pool.

System-Planning Studies. The paper was written primarily to point up a tool which Detroit Edison is using to calculate system fuel costs. However, when studies are conducted which involve alternate plans for installing generating capability at different locations transmission costs and transmission losses are accounted for in the study.

Table of Definitions. One discusser questioned the optimistic plant costs shown for plants where large gains in efficiency are indicated. These plant costs are Detroit Edison's estimate of what this Company could afford at the present time to pay for this equipment on a break-even basis, not necessarily what the plant would actually cost.

The authors would be happy to make this program available to any who might be contemplating such studies or to answer further questions concerning the program.

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Kinematics: A German-English Glossary

Comment by Erwin Bunzel[12]

Although it is 72 years since I went to school [in Germany] and learned the fundamentals of geometry, it is possible that the nomenclature of certain items has changed.

With reference to page 52 of this paper,[13] in my time "Rechteck" was a rectangle. "Rechtwinklig" was a 90-deg right angle.

I remember when my teacher explained right angles. He drew a sketch thus ∟ and said this is *ein rechter Winkel* and then he drew a sketch thus ⌋ and called upon me asking, "*Was ist dieser Winkel?*" And I, comparing the two sketches, exclaimed triumphantly, "*Dies ist ein linker Winkel*"; reasoning that the first sketch pointed to the right and the second sketch to the left.

Have the definitions changed lately?

Comment by F. R. E. Crossley[14]

The compilers of this glossary[13] should be congratulated most heartily on the remarkably comprehensive collection that they have achieved. The work is most timely, for many of us here with all too rudimentary a knowledge of German are earnestly searching the German literature, and are aware of the great strides that have been taken in the development of this special branch of technology. This glossary will be a great help. In my own recent translations I have made a point, since this glossary appeared, of checking to see if many words were here that I happened to encounter; I have been astonished that nearly all were. Nevertheless (and I am quite sure that I will not be the only one to make this comment), there is always room for a few additions.

In connection with cams, I note that Dr. Rankers uses not **Kurvenscheibe** but **Scheibenkurve** for disk cam, and this is contrasted with

Trommelkurve: cylindrical or barrel cam

Then there are the followers:

Flachstössel: push-rod with flat end, or flat sliding cam-follower
Rollenstössel: sliding cam-follower or push-rod with cam-roll
Rollenschwinge: hinged cam-follower arm with roller

The root words **Schalt-** and **Sperr-** have much wider significance than seems to be indicated in the glossary as yet. For instance, Professor Bock writes: "Die Bezeichnung 'Schaltgetriebe' wird (leider) für 2 Arten von Getrieben verwendet, nämlich für 'schaltende' Getriebe, wie z.B. das Malteserkreuzgetriebe, und 'schaltbare' Getriebe, wie z.B. das Kraftwagengetriebe." He defines the former type as any mechanism for producing an advancing motion with periodically recurring dwell periods, during which there is simultaneously provided a means for holding the output member still and transmitting no power from the input.

Schaltgetriebe: intermittent drive, or changeable speed mechanism
schaltbares Getriebe: change-speed gear or transmission
schaltendes Getriebe: intermittent drive mechanism

Among the latter are found Geneva-wheels of all sorts, also

Sternradgetriebe: star-wheel mechanism (as distinct from Stirnrad)
Zahnradschaltgetriebe: toothed gear drive with intermittent or variable velocity ratio

Devices with a ratchet generally have intermittent movement, but the Germans recognize two sorts:

Klinkenschaltgetriebe: a pawl and rachet indexing or intermittent feed mechanism (as in Fig. 1)
Klinkensperrung: a pawl-held indexing positioner (as in Fig. 2)

With these the detail parts are

Gesperre: pawl, click, detent
Schaltklinke: intermittently driving pawl (Fig. 1 piece No. 4)
Sperrklinke: pawl for holding or locking (Fig. 1 piece No. 6, and Fig. 2), stop-pawl
Schaltrad: ratchet wheel

Sperren conveys the notions of holding, holding off, enforcing an interval or separation. Thus **Schaltung** and **Sperrung** are the two mutually complementing actions of many intermittent drives. For example, in the action of Geneva and star wheels, during the dwell period, there is

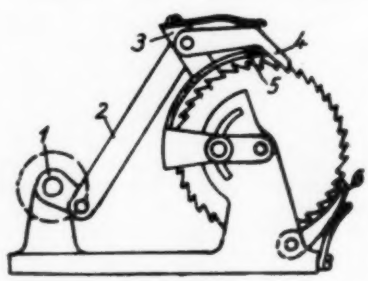

Fig. 1

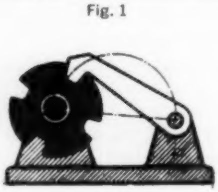
Fig. 2

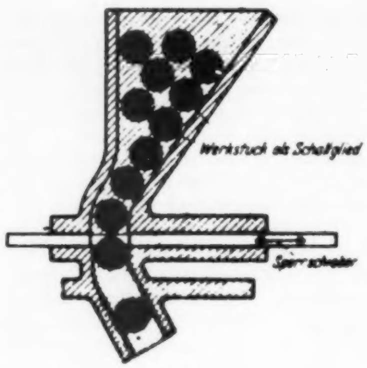

Fig. 3a

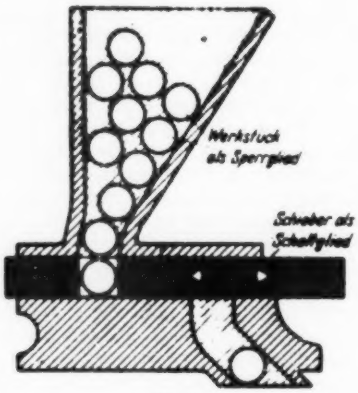

Fig. 3b

Zylindersperrung: Holding still by means of the sliding engagement of cylindrical surfaces
Sperrschuh: sliding shoe for holding or locking

Analogous to **Sperrung,** but distinguished from it by Rauh,[15] by many illustrations, is

Befestigung: locking, interlocking, or halting action by wedge, pawl, or sprag; device for the same.

The purpose of all of these mechanisms is accomplished by the interaction of two members, a **Schaltglied** and a **Sperrglied**. The distinction can get quite fine, as when Rauh discusses the two intermittent-action feed mechanisms shown in Fig. 3. Here we find:

Absperren: to separate
Absperrschieber, Sperrschieber: separating slide or gate

and he notes that in the arrangement of Fig. 3a we have "Werkstücke als Schalt-

[12] Retired, Orlando, Fla. Mem. ASME.
[13] R. S. Hartenberg and T. P. Goodman, "Kinematics: A German-English Glossary," Mechanical Engineering, vol. 82, December, 1960, pp. 49–53.
[14] Associate professor of mechanical engineering, Yale University, New Haven, Conn. Mem. ASME.
[15] Kurt Rauh, "Praktische Getriebelehre," Springer Verlag, 1954.

glied; Sperrschieber als Sperrglied," while in contrast in the style shown at Fig. 3b, "Werkstücke als Sperrglied; Schieber als Schaltglied." Both are classed **Sperrtrieb.** To translate these, we may use

Sperrtrieb: locking mechanism, mechanism to shut off a supply, or stop a drive, generally temporarily
Sperrglied: stopping device, pawl, sprag; also barrier, obstruction, gate; separator
Schaltglied: member having alternating motion, or intermittent motion; sliding or rotating shutter (cf. **Schalter:** bank teller's window); door or gate opening, switching device or agent

Schalten has still another meaning, most frequently used in an electrical context to mean "to incorporate in a circuit." In this sense, Hain, when writing on linkage mechanisms having dwell periods in output, entitles a paragraph "Hubgetriebe mit Sperrlagen," and starts "Schaltet man zwei Gelenkvierecke hintereinander, . . . , so hat man ein Gesamtgetriebe erhalten, das . . ." From these we get

schalten: to connect together (in series), to compound (linkages), to incorporate (into a circuit or system)
nachschalten: to connect in an after position, further from the input
vorschalten: to connect before, or ahead of
Sperrlage, Sperrstellung: position of hesitation, dwell position
Hubgetriebe: lifting mechanism, linkage to actuate a lift-arm or lever

Two suggestions: That with collaboration a similar glossary of Russian terms be collected, and that a continuing committee attend to their proper publication and periodic revision.

Comment by Douglas P. Adams[16]

This glossary[13] should prove a useful compilation indeed to many a kinematician. Those who are just starting to read the subject in German will be the chief gainers, yet quite frequently also those who are not blessed with good powers of retention of foreign vocabularies will be able to utilize this glossary.

The five or six-hundred-word selection here frequently turns out to be remarkably useful even to persons who believe themselves so blessed—for it is well chosen indeed. One can read many pages of normal kinematics text and seldom find a single word not included in this helpful set.

When a job is as well and usefully done as this, the authors invariably are solicited for the next stage of the same problem, which I would gather is clearly the task of compiling the English-German glossary for the same purpose. In many ways this would be expedited by the job already done, but would not necessarily turn out to be the exact inverse. The greater natural facility of the authors with English would probably turn up a few words and phrases whose German counterparts had been overlooked in the former listing.

The authors have demonstrated for English and German that the idiom of a language can seldom be perfectly explored by the phrases of another. There must always be new expressions as well as rare older ones cropping up for which it would be helpful to have the preferred meaning. If those who come across such expressions would kindly send them to the authors of the article, an ever-increasing and improving compilation could be made. There are also the words of peripheral affiliation which hopefully the authors would encourage. Five such words encountered naturally, illustrating somewhat increasing need of help with the idiom, might run as follows:

Stab: rod, brace, member
Weglassung: omission
Neigungswinkel: angle of inclination
Schwungrad: flyweeel
Spannung: tension, stretching, extension

Prof. Dwight Baumann has suggested that, in the English version of the elevation view of the valve, the changes be made:

union plug: hand nut
helical spring: indicator spring
cylinder: cylinder insert

This paper was presented close to the moment when the sad news of the death of Prof. Rudolph A. Beyer (see Obituaries, MECHANICAL ENGINEERING, April, 1961, p. 131), past-professor at the Technische Hochschule, Munchen, and visiting professor at Yale, was received.

Would it not perhaps, be appropriate to dedicate this useful and growing work to his memory? If, in addition, contributors were recognized, the growth of this list might be quite rapid. In this, and presumably several other ways, the eminence and esteem of Professor Beyer in the hearts of his American colleagues who owe so much to his visits here might fittingly be memorialized.

Comment by K. Hain[17]

The authors did a useful work to start the correct translation of kinematic terms, and it will be necessary to continue these efforts. Here are some other words:

Darstellende Geometrie: descriptive geometry
Druckmittelgetriebe: pressure link mechanism
Flachstössel: flat-faced follower
Gelenkwelle: universal joint
Getriebe mit schnellem Rückgang: quick-return mechanism
Gleichdick-Kurvengetriebe: constant-breadth cam
Gleitkurvengetriebe: sliding-contact mechanism
Kurvengetriebe mit konstantem Durchmesser: constant diameter cam
Räderkurbelgetriebe: gear drive
Schubkurvengetriebe: translation cam
Trommelkurvengetriebe: cylindrical cam
Wälzkurvengetriebe: rolling-contact mechanism
Zugmittelgetriebe: tension link mechanism

Comment by D. A. Klimm[18]

I have enjoyed your December, 1960, issue with particular interest in the article[13] on "Kinematics." Being a German technical translator for an Air Force Engineering Office I agree with every point you mention in this fine article.

However, under consideration of the contents of this article I would like to point out that some terminologies are truly misinterpretations, no matter how widespread a range one grants a commonly used term.

This statement comes from a man who has had 13 years of college-type education plus four years mechanical experience with a Government diploma of general engineering and seven and a half years as a civilian with the U. S. Air Force (technical branch) here in Germany.

The following is a correction of the original glossary.

(*a*) 1 Antrieb: input *should read* Antrieb: drive, gear, impulse
Eingangsenergie, Eingangskraft: input
2 Betrag: magnitude should read
Betrag: amount, sum
Groessenordnung: magnitude
Doppelantrieb: dual drive
3 Herz: simply stands for "heart" and has no relation with this subject
4 Hertz: this stands for the great scientist Heinrich R. Hertz who determined the frequency impulses
Hz: is the correct abbreviation.
5 Luft: play, clearance, also used throughout is "Spiel"
6 Schleife: loop, *not* slide
Gleiten, rutschen: slide
7 Weg: itself does not stand for displacement *but* Verdraengung(sweg)—way of displacement
8 (An) Naeherung *not* Nachrerung.

(*b*) Throughout this glossary you equal "Getriebe" with mechanism. "Getriebe" is commonly understood as a

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[17] Professor of engineering, Braunschweig, Germany.

[18] German technical translator, AF Engineering Office, Spangdahlem AB, Eifel, Germany.

(rotating) gear train, transmission (pinion drive).

When a nonrotating mechanism is meant, better refer to:

Antrieb, Gestaengeantrieb, Steuerung: linkage drive

durchschlagendes Getriebe: folding linkage *should read* durchschlagender Gestaengeantrieb

You will find most any of these terms in one of Germany's best technical dictionaries, issued by Dr. Richard Ernst, Brandstetter Verlag, Wiesbaden, Germany.

Authors' Closure

The authors appreciate the several written comments, and wish to express their hearty thanks for the interest and constructive suggestions.

Mr. Bunzel is quite correct: *Rechteck*, even today, is a rectangle. *Rechteckig* means rectangular, i.e., four right angles are present, also implied in *rechtwinklig*. This *rechter Winkel* is the right angle of English, viz., 90 degrees.

Professor Crossley's *Scheibenkurve* (via Dr. Rankers) should have been included as an alternate for *Kurvenscheibe;* either is proper for disk cam. Perhaps we should note that the late Professor Beyer used *Kurvenscheibe;* the lack of a standard terminology, remarked upon in the introduction to the Glossary, is evident here. Questions of usage and preference always arise, no matter what the language. Thus the authors' suggestions for the "follower" glosses would be: *Flachstössel*, translating flat-faced follower; *Rollenstössel*, translating roller follower; *Rollenschwinge*, oscillating roller follower. Professor Bock, quoted as lamenting the casual application of *Schaltgetriebe* to both *schaltende Getriebe* and *schaltbare Getriebe*, certainly has a point. They are different from each other, and by way of further definition one might say that a *schaltendes Getriebe* has a self-induced advance whereas the *schaltbares Getriebe* needs external motivation (as by a gear-shift lever). Familiarity breeds confusion; in some circles, gearbox, transmission, and *Getriebe* are identical with *schaltbares Getriebe*, sometimes called *Wechselgetriebe!* Not content with this, *Getriebe* by itself often designates a reduction gear of fixed speed ratio. These multiple choices, each "correct" for a certain group, would soon make a translating machine a psychiatric case if the machine had a moral sense.

Professor Adams' remarks on the future—extension of the present work, its transformation into English-German, and inclusion of the Russian—present problems. An enlargement of the effort would appear to involve a continuing committee (to use Professor Crossley's words), a way of publishing the results, and some degree of financial support beyond the casual. Some as yet unresolved thoughts have been given these matters. Plans for a proper recognition of Professor Beyer's influence are already in a formative stage. We might remark—and it is not an original observation—that no completely satisfactory medium exists for the continuous presentation of kinematic work, and that this challenge should also be explored at length. Thus a "Kinematic Supplement" to an existing journal might be more attractive than a new journal.

The authors welcome Professor Baumann's remarks on the indicator used to "illustrate" the article. The indicator, added to the Glossary by the editors without consulting the authors, has been a source of embarrassment. First, the indicator has nothing to do with the Glossary; second, the translations are hardly on a one-to-one basis. To identify the critical part, the *Indikatorfeder*, as helical spring, is a wide miss of the point. Furthermore, several of the German legends are not translated at all, which seems odd indeed.

In all other respects, the authors were well pleased with the format and typography which the editors provided for the paper. The authors wish to take this opportunity to express their appreciation to the staff of Mechanical Engineering for its painstaking efforts on a difficult typesetting task.

The glosses of Professor Hain again point up the troubles of word usage, e.g., the associations with *wälzen*. To some German authors, *wälzen* means only rolling (or rolling contact); to others, both rolling and sliding (in combination). This last group might then distinguish among *rollen*, *wälzen*, and *gleiten*—rolling, rolling together with sliding, and sliding. A *Gelenkwelle* is a specific kind of universal joint, viz., the Hooke type; and *Räderkurbelgetriebe* is more safely rendered as gear-crank mechanism, with linkage-gear mechanism as second choice.

The authors do not agree with Mr. Klimm's allegations re misinterpretations. The glossary deals with word usage as it exists in the classical and current literature of kinematics—the works of Reuleaux, Burmester, Alt, Beyer, Meyer zur Capellen, and many others. The authors were careful to remark that "This glossary presents a special vocabulary not found in dictionaries." They might and evidently should have been more precise and said that the glossary presents in the main certain idiomatic, colloquial, and technical expressions peculiar to kinematics, and in desperate need of treatment. Dr. Ernst's dictionary is good, and there are others—as Hoyer-Kreuter and Leidecker—but all need the support of a specialist's glossary. For example, Ernst gives turning circle for *Wendekreis*, fine when talking about automobiles but wrong when the kinematician is really in need of an inflexion circle, the circle of de la Hire. Ernst equates the adjective *viergliedrig* to quadrinominal, which should allow us to translate *viergliedriges Getriebe* into the truly sensational quadrinominal mechanism instead of the homely four-bar linkage. And the word has been quadrinominal for many decades. Ernst's crank slot for *Kurbelschleife* makes no sense.

To the two typographical errors noted by Mr. Klimm, a third should be added: *zugeordnete* has only one *t*. As kinematicians, the authors still back their entries for *Antrieb* (input), *Doppelantrieb*, (double input), and *Weg* (displacement), especially the last. The common ordinary garden variety of *Weg* is one thing, and the dynamicist's *Weg* quite another, being necessary for the distinction between velocity and speed. *Schleife* did get a cavalier treatment through lack of elaboration of the meaning of slide. A *Schleife* is a straight crosshead that is turning, as in inversions of the slider-crank mechanism; i.e., *Schleife* is a rotating *Gleitschiene*, certainly a slide. The slider would be the crosshead itself, the *Gleitstein*. *Schleife* is an unhappy term, for it usually means loop. But it also means slide, and not only in kinematics. The patch of ice on which children slide is in Germany variously called *Schleife*, *Schlitterbahn*, *Glitsche*, or *Glitschbahn*. From *glitschen* one sees a colloquial relation to *gleiten*. To the lumberman, a *Schleife* is the skidway or track on a mountainside down which logs are slid; *Schleife* is also the track of a sled runner.

The admonition to limit the meaning of *Getriebe* to "(rotating) gear train, transmission (pinion drive)" is impossible to follow, since the Germans themselves have other ideas, starting from the titles of the books they write: *Konstruktive Getriebelehre* (Hagedorn); *Angewandte Getriebelehre* (Hain); *Praktische Getriebe* (Rauh); *Einfache Getriebe* (Sieker); and so on.

R. S. Hartenberg.[19]
T. P. Goodman.[20]

[19] Professor of mechanical engineering Northwestern University, Evanston, Ill. Mem. ASME.

[20] Kinematics engineer, General Engineering Laboratory, General Electric Company, Schenectady, N. Y. Mem. ASME.

Notes on Books Received in Engineering Societies Library

REVIEWS OF BOOKS

The Consulting Engineer

The Consulting Engineer

By C. Maxwell Stanley. John Wiley & Sons, Inc., New York, N. Y., 1961. Cloth, 5¼ × 8½ in., appendixes, index, viii and 258 pp., $5.95.

Reviewed by Hunter Hughes[1]

ONCE, when an old newspaper reporter was standing with several of his colleagues at a bar, he turned to them and said, "If I could tell you what I know, I'd be the smartest man in the world." If C. Maxwell Stanley, in his book "The Consulting Engineer," could tell what he knows about consulting engineering, he would be right up there with the reporter. For Mr. Stanley is an outstanding consulting engineer whose firm has done and continues to do fine work here and abroad, and if, through his book, he could bring all other private practitioners up to his level, he would indeed have helped the profession.

In his preface, Mr. Stanley says that he hopes his book "will be helpful to both consulting engineers and those who engage them. . . May it inform and interest students and young engineers seeking knowledge of the consulting engineering profession." That is asking too much of one book. Those who engage consulting engineers, the clients, are as unlikely to read this book as are those in trouble with the law to read a book called *The Practicing Attorney*. Consulting engineers (if by this term we mean the men who head their own firms of engineers) already know or never will know all Mr. Stanley has managed to put into his book that is of great importance to their business and professional success.

There still remain, however, as potential readers "students and young engineers seeking knowledge of the consulting profession." This would make an excellent text for study as part of some senior course for engineering students, a course designed to tell these students of the several directions—industry, government, or private practice—in which a young engineer can aim himself in the profession. Unfortunately, there are no such courses taught in engineering schools, and while there have been some efforts made to encourage their addition to the curriculum; so far, no success.

This leaves the "young engineers." For them this book is ideal. When a bright young man joins a firm of consulting engineers, he seldom has much trouble keeping up technically with those around him. Technical proficiency comes fast for most, and with just a little experience on a few projects, there need be no difference in the technical ability of the young engineer still on the tender side of thirty and a fellow employee on the tough side of fifty. It is not often that technical ability or engineering experience makes the successful consulting engineer. Success comes from astute application of business knowledge and professional ways and means.

It is in this area and at the level of the ambitious young employee in an engineering firm that Mr. Stanley has made an important contribution to the literature of the profession. This is true of both parts of his book, the first of which deals with the many aspects of engineer-client relations (services, fees, selection of the engineer), while the second takes up the management of an engineering firm. Obviously, both of these (the "outside" and the "inside" aspects of private practice) are involved in the success of every firm.

This book might more accurately have been entitled, ***What Every Young Would-Be Consulting Engineer Should Know***. Within these limits it is excellent. The charts, tables, statistics, fee schedules, and sample contracts contain nothing new, nothing that has not been published before, but nowhere else can it all be found in one publication, and all is amazingly accurate and current. Furthermore, Mr. Stanley's commentary shows that he has a comprehension, seldom found even among the oldest and wisest of his colleagues, of the meaning of the facts he has brought together.

If Mr. Stanley has not been able to tell all he knows, he has been able to tell much that the bright young man on his way up does not know. There are perhaps 15,000 of these fair-haired boys today in engineering firms, and every one of them should get a copy of this book and read it at least twice. They still will not know as much as the boss, but they will be getting close.

[1] Managing director, American Engineering Consultants, Inc., Washington, D. C. Mem. ASME.

BOOKS RECEIVED IN LIBRARY

Boundary Layer Theory

By Hermann Schlichting. Fourth Edition. 1960, McGraw-Hill Book Company, Inc., New York, N. Y. 647 p., 6½ × 9½ in., bound. $16.50. This second English edition constitutes the fourth edition of the original. The translator worked with the author in its preparation, and it more nearly reflects the present status in the development of this branch of science than any other edition including the third German edition (1958). The book starts from first principles and develops the subject to its most recent advances, including revisions particularly in the treatment of transition, nonsteady boundary layers, thermal boundary layers, and suction.

Comparative Effects of Radiation

Edited by Milton Burton and others. 1960, John Wiley & Sons, Inc., New York, N. Y. 426 p., 6 × 9¼ in., bound. $8.50. This book is a report on comparative effects of ionizing, ultraviolet, visible and near-infrared radiations as they were examined and interpreted by a group of biologists, chemists, and physicists at a February, 1960, Conference held at the University of Puerto Rico, jointly sponsored by the National Research Council, the National Science Foundation, and the

Atomic Energy Commission. In 14 chapters, each a seminar on a particular topic, and a summary chapter, such topics as plant-growth control, photoreactivation, molecular photochemistry, effects on biological and chemical systems, excitation transfer and energy-transfer processes, irradiated polymers, and radiation chemistry of water are discussed.

Computer Logic

By Ivan Flores. 1960, Prentice-Hall, Inc., Englewood Cliffs, N. J. 458 p., $6^1/_4 \times 9^1/_4$ in., bound. $12. This book considers computers first at the over-all or highest level of organization, and proceeds later to lower levels of detail, emphasizing the organization and functional interrelationships of the fundamental units, which are discussed from the point of view of operational necessity. Minimum engineering and mathematical background is required to learn from this book how computers are put together, how they work, and how to use them.

Einführung in die Korngrössenmesstechnik

By W. Batel. 1960, Springer-Verlag, Berlin, Germany. 156 p., $6^1/_2 \times 9^1/_2$ in., bound. DM 27.00. A systematic presentation of research in the field of particle-size measurement. Topics treated include sampling, measurement techniques for size and frequency determinations, the significance of particle size, aerosols, dusts, etc. Methods are given for determining surface and other physical characteristics of granular materials. The final chapter contains examples for the application of particle analysis.

Electronics and Nucleonics Dictionary

By Nelson M. Cooke and John Markus. 1960, McGraw-Hill Book Company, Inc., New York, N. Y. 543 p., $6^1/_4 \times 9^1/_4$ in., bound. $12. An illustrated dictionary giving definitions, abbreviations, and synonyms for more than 13,000 terms used in television, radio, medical, industrial, space and military electronics, avionics, radar, and nuclear science and engineering. Actually a second edition of "Electronics Dictionary" (1945), it bears little resemblance to its predecessor, showing vast changes in meanings of the old terms, addition of many new terms, and interlocking of the terminologies of nucleonics and electronics. It consistently adheres to common usage and standardization by engineering organizations in controversial cases, so that it becomes, in effect, a style guide also.

Elementare Schalenstatik

By Alf Pflüger. Third Edition. 1960, Springer-Verlag, Berlin, Germany. 112 p., $6^1/_2 \times 9^1/_2$ in., bound. DM 19.50. An introductory treatise on the statics of shells. Originally published as a textbook, the new edition has been enlarged and revised so as to be useful to the practicing engineer as well. After a brief explanation of the shell concept, the author discusses in detail the membrane theory of rotation shells, the bending theory of rotation shells, and specifically, the membrane theory of cylindrical shells. There are also notes on the states of stress and a tabular summary of membrane theory solutions for shells of various forms.

Embrittlement by Liquid Metals

By W. Rostoker and others. 1960, Reinhold Publishing Corporation, New York, N. Y. 162 p., $6^1/_4 \times 9^1/_2$ in., bound. $7.95. This book describes embrittlement by liquid metals, and advances a thesis on its fundamental significance, treating the subject as a scientific phenomenon, but pointing out its destructive nature from an engineering viewpoint. The first chapter is a review of the literature on the subject. Succeeding chapters discuss liquid metal embrittlement from the standpoint of its occurrence, influencing factors, delayed failure, and mechanism as well as crack propagation and the theory of fracture of metal.

LIBRARY SERVICES

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Feuerfestkunde

By Friedrich Harders and Sigismund Kienow. 1960, Springer-Verlag, Berlin, Germany. 981 p., 7×10 in., bound. DM 126.00. This extensive treatise on refractories is divided into sections by the major types: silica, fireclay, alumina, basic and neutral, etc. Within each section are given the basic physical, chemical, and mineralogical characteristics, raw materials and their origin, manufacture, properties of the fabricated materials, applications. Certain other insulating materials such as asbestos and vermiculite are also briefly treated. An appendix contains phase diagrams and detailed indexes.

Grundlagen der Selbsttätigen Regelung, Vol. 2: Einige Probleme aus der Theorie der Nichtlinearen Regelungssysteme

By W. W. Solodownikow. 1959, R. Oldenburg Verlag, Munich, Germany. 1180 p., $6^3/_4 \times 9^1/_2$ in., bound. DM 52.00. This German translation from the original Russian is the second of two volumes on the fundamentals of automatic control. It deals with theoretical problems of nonlinear control systems, the idea of the phase space and its application in solving nonlinear problems, approximate methods of investigation of periodic phenomena in control systems, and grapho-analytic methods for constructing transition processes in control systems with nonlinear and changing parameters. The presentation is both extensive and detailed. The appendix includes tables of h-functions and a 50-page bibliography.

Heating, Ventilating, Air-Conditioning Guide, 1960, Vol. 38

Published 1960 by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., New York, N. Y. 468 p., $8^3/_4 \times 11^1/_4$ in., bound. No price given. The Technical Data section of the 1960 "Guide" is the largest yet, due to the inclusion of new material on thermodynamics, sound control, restaurant hot-water requirements, sizing storage tanks, coils and heaters, fundamentals, detection and control of odor, residential air conditioning, and many other topics, as well as condensed and revised material from the previous edition. The Catalog Section, as before, contains indexes to manufacturers, and to equipment, as well as manufacturers' catalog data.

Hydraulic Handbook

Compiled by Editors *Hydraulic Power Transmission*. Second Edition. 1960, Trade & Technical Press, Ltd., Marden, Surrey, England. 793 p., $7^1/_2 \times 10$ in., bound. 100s. This handbook was compiled by the editors of the official journal of the (British) Association of Hydraulic Equipment Manufacturers. Section 1-A summarizes the principles of hydraulics. Section 1-B describes hydraulic equipment from accumulators to valves, including electrical and remote controls, hydraulic fluids, and servomechanisms. Section 2 contains descriptions and diagrams of hydraulic and electrohydraulic circuits; hydraulic computation data in the form of formulas, tables, charts, and nomograms; and a glossary of hydraulic symbols and terminology. Section 3 is a Buyers' guide, containing an index of trade names, of manufacturers, and of hydraulic equipment and components. There is a precise index to the entire handbook.

Industrial Electric Furnaces and Appliances

By V. Paschkis and John Persson. Second Edition. 1960, Interscience Publishers, Inc., New York, N. Y. 607 p., $6^1/_4 \times 9^1/_4$ in., bound. $24. The original two-volume edition has been consolidated into one volume, and much of the material revised. The five chapters are detailed discussions of individual topics, the first dealing with thermal problems, electrical laws, and economic considerations. The remaining chapters discuss arc furnaces, resistance furnaces, induction and dielectric heating, and selection of furnaces for specific applications.

Inertial Guidance

By Charles S. Draper and others. 1960, Pergamon Press, Inc., New York, N. Y. 130 p., $6^1/_4 \times 9^1/_4$ in., bound. $6.50. A graduate-level description of the physical principles and engineering methods underlying the navigation and control of vehicles solely by means of signals from sensors that depend only on the inertial properties of matter for their operation. The development proceeds from an examination of traditional navigation in terms of physics, through a discussion of past uses of inertia in navigation, to the interpretation of the operations of navigation in terms of control theory. The problems discussed include the most recent ballistic missile guidance, and the use of gyros in geometrical stabilization.

Infrared Methods

By G. K. T. Conn and D. G. Avery. 1960, Academic Press, New York, N. Y. 203 p., $6^1/_4 \times 9^1/_2$ in., bound. $6.80. An introduction to infrared studies for the research student and the student in allied fields. The first section briefly describes the chief components used in exploring the infrared region, covering such topics as sources, optical materials and filters, detectors, amplifiers, and dispersive systems, from the standpoint of principles and purposes. The second section is devoted to practical applications, as in calibration of detectors, monochromators, gas analysis and plant-control instrumentation, and radiation pyrometry.

International Conference on Nuclear Structure, Proceedings

Edited by D. A. Bromley and E. W. Vogt. 1960, University of Toronto Press, Toronto, Canada. 990 p., $6^3/_4 \times 10$ in., bound. $16.75. Nearly 500 scientists from all over

the world attended the conference held in Kingston, Ont., in August-September, 1960. Three hundred research contributions were received at Conference headquarters. Just five weeks after the Conference this volume was published, containing 127 of the papers received, and a list with abstracts of all of the contributions. The topics covered by the published papers include the physical foundations of nuclear models, properties of nuclear matter, nuclear reaction mechanisms, properties and statistics of nuclear levels, and fission.

The International Dictionary of Applied Mathematics

Published 1960 by D. Van Nostrand Company, Inc., Princeton, N. J. 1173 p., $7^1/_2 \times 10^1/_4$ in., bound. $25. This dictionary defines terms and describes methods in general and fruitful use in the applications of mathematics to 31 fields of science and engineering, and also defines terms from other fields which have been used in the definitions and descriptions of the applied mathematics concepts and methods. The 39 contributing editors are specialists in the 31 fields in Canada, Great Britain, Belgium, Australia, and the U. S. A. A useful feature is the group of four-language indexes listing alphabetically the French, German, Russian, and Spanish terms with the English equivalent, compiled by four translators, three from American universities, and the fourth the editor of *Soviet Physics*.

Konstruktionen und Bauelemente von Strömungsmaschinen

By H. Petermann. 1960, Springer-Verlag, Berlin, Germany. 76 p., $8^1/_2 \times 11^1/$ in., paper. DM 12.00. A collection of photographs and drawings showing designs and structural elements of turbomachinery intended to help both the student and the practicing engineer in solving design problems. The examples represent the work of leading manufacturers and depict high-temperature steam turbines, gas turbines, compressors, turbochargers, and various types of pumps, particularly for high-pressure applications.

Linear Programming and the Theory of the Firm

By Kenneth E. Boulding and W. Allen Spivey. 1960, The Macmillan Company, New York, N. Y. 227 p., $6^1/_4 \times 9^1/_2$ in., bound. $8. Linear programming and its effects on contemporary economic and management theory are the subjects of this work, the product of a Ford Foundation-sponsored seminar for college economics teachers held at the University of Michigan in 1958. It consists of seven essays which deal with the theory of the firm as an explicit segment of economic analysis, linear programming and its basic mathematical concepts, a comparison of marginal analysis and mathematical programming in the theory of the firm, operations research, and a managerial theory of the firm. There is an extensive bibliography.

Management Control Systems

Edited by Donald G. Malcolm and Alan J. Rowe. 1960, John Wiley & Sons, Inc., New York, N. Y. 375 p., $6 \times 9^1/_4$ in., bound. $7.25. The Systems Development Corporation organized a Symposium in Santa Monica in July, 1959, to discuss the evolution of effective management concepts, utilizing electronics, for modern industry. Nineteen management experts from business and government, as well as SDC personnel, participated, and the papers and discussions are presented in this book. Appraisal of the state of the art is the focus of the papers, which deal with concepts of management control and present practices in both business and military departments, the impact of computers on the design of management controls, some examples of automated management controls, future possibilities in management control, and in information systems, and the need for research in management control system design.

Modern Approaches to Production Planning and Control

Edited by Robert A. Pritzker and Robert A. Gring. 1960, American Management Association, Inc., New York, N. Y. 445 p., $6^1/_4 \times 9^1/_2$ in., bound. $9. This organized collection of essays aims to provide management with possible solutions or suggested approaches to problems in production planning and control. Its first three sections deal with the separate phases of the process—organization and administration; planning tools and control techniques; and mechanical and mathematical aids. In each essay, specific steps are examined in detail. The sections are general in their application, the balance between theory and practical illustration being left in each case to the individual author. In the final section, three case studies of existing systems or unusual interest are presented—in a plant making airbrake equipment, in a steel company, and in a chemical and dyestuffs company.

Petroleum Engineering

By Carl Gatlin. 1960, Prentice-Hall, Inc., Englewood Cliffs, N. J. 341 p., $8^3/_4 \times 11^1/_4$ in., bound. $13. General chapters on the properties of reservoir rocks and fluids, exploration and leasing practices, core analysis, well logging, and formation damage provide background material for readers without prior knowledge of this field. More detailed chapters on cable tool and rotary drilling, drill-stem testing, and cementing, casing, and completion practices combine with these general chapters to provide an integrated picture of drilling and well-completion operations as they are normally encountered by the petroleum engineer.

Solid Propellant Rocket Research

Edited by Martin Summerfield. 1960, Academic Press, Inc., New York, N. Y. 692 p., $6^1/_4 \times 9^1/_2$ in., bound. $6.50. This selection of technical papers, based mainly on a symposium of the American Rocket Society held at Princeton University in January, 1960, forms the first volume of the Society's new series, "Progress in Astronautics and Rocketry." The next four volumes will appear in 1960-1961. In this volume the papers are arranged in sections dealing with steady-state burning of composite propellants, combustion of metals, unstable burning in solid propellant rockets, ignition, and the mechanical properties of solid-propellant grains. Most of the papers in each section deal with basic phenomena, but some papers on engineering aspects are included.

Strömungslehre, Vol. 1: Hydro- und Aerostatik; Bewegung der Idealen Flüssigkeit

By O. Tietjens. 1960, Springer-Verlag, Berlin, Germany. 536 p., $6^1/_2 \times 9^1/_2$ in., bound. DM 66.00. This first volume of a treatise on fluid dynamics deals with hydro and aerostatics and the motion of an ideal fluid. Emphasis has been put on physical data, from a technical point of view. Basic concepts, such as energy, acceleration, flow lines, etc., are discussed and applied to common problems. The mathematical treatment is always carried through to numerical evaluation, and typical examples are given; therefore a large number of calculated flow patterns have been included. Although the book deals essentially with motion of the ideal fluid, a vital relation to ordinary fluids and gases has been maintained, and reference is often made thereto.

Symposium on Nondestructive Testing in the Missile Industry

Published 1960 as ASTM Special Technical Publication No. 278 by the American Society for Testing Materials, Philadelphia, Pa. 71 p., $6^1/_4 \times 9^1/_4$ in., bound. $2. This volume contains seven of the eight papers presented at the Symposium, held in San Francisco on Oct. 12, 1959. Included are papers on radiography of rocket motors, of weldments in motion, and in the 6 to 30-Mev range; ultrasonics in sandwich structures inspection, fluid-contaminating particle detection, and evaluation of missile materials and components; and mobile field inspection of missiles and aircraft.

ASME BOILER AND PRESSURE VESSEL CODE

Interpretations

The Boiler and Pressure Vessel Committee meets regularly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th St., New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in Mechanical Engineering.

(The following Case Interpretations were formulated at the Committee meeting March 17, 1961, and approved by the Board May 10, 1961.)

Case 1064-1

(*Special Ruling*)

Low-Pressure Heating Boilers of Copper or Copper Base Alloys

, Revise as follows:

In the reply, subparagraph (1) Material, delete reference to Grades 2 and 4 of SB-11 and substitute Grades DHP and DPA and SB-171.

In subparagraph (8) Welding, line 5, delete reference A.W.S. and in the seventh line revise reference to the specification to read: SB-225

Subparagraph (9) delete and substitute the following:

· (9) Brazing. Except where this Case covers other requirements, brazing shall conform to Section IX, Welding Qualifications, Part C, Requirements for Brazing Ferrous and Nonferrous Materials.

A longitudinal lap joint shall have the edges of the plate lapped a distance of not less than 8 times the thickness of the shell plate. For double-strap butt joint construction the total amount of lap of the inner and outer straps shall be equal to at least 16 times the thickness of the shell plate, one half of which shall be on each side of the abutting edges. The width of these straps shall not differ more than 25 per cent of the width of the wider one. The laps shall be held closely in position substantially metal to metal by stitch riveting or other sufficient means.* The brazing shall be done by placing the flux and brazing material on one side of the joint and applying heat until this material comes entirely through the lap and shows uniformly along the seam on the other side. Sufficient flux must be used to cause the brazing material to appear so promptly after reaching the brazing temperature.

When the brazed joint does not extend the full length of the sheet, the unbrazed edges may be welded provided the length of the weld is not greater than 4t (t = thickness of shell plate) from the edge of the flange of the head.

Head and Girth Joints. Heads shall be inserted into the shell with a tight drive or shrink fit and shall be thoroughly brazed in approximately the same manner as the longitudinal seam for a depth or distance from the end of the shell equal to at least 4 times the thickness of the shell metal. When a vessel is fabricated with more than one course in the shell, the girth joint may be of either the lap or butt type. If of the latter type, the circumference of the abutting courses shall not differ by more than 0.20 per cent and either inside or outside sleeves shall be used. In either case the lap over the end of each course shall be at least 4 times the shell thickness.

* When the safety of the structure does not depend upon the riveting in the joints, rivet holes may be punched full size.

Case 1204-8

(*Special Ruling*)

Quenched and Tempered Steel

Par. (4) of the Reply, revise to read:

The maximum allowable stress values shall be as shown in Table I.

Table I

Temp F	Max Allowable Stress for Plates Up to 2 In., Inclusive, Psi	Max Allowable Stress for Plates Over 2 In. to 2 ½ In, Psi
−20 to 150	28,750	26,250
200	27,750	25,350
300	26,750	24,400
400	26,000	23,750
500	26,000	23,750
600	26,000	23,750
650	25,000	22,800

Case 1297-1

(*Special Ruling*)

Quenched and Tempered Steel

Par. (4) of the reply, revise to read:

The maximum allowable stress values shall be:

Temp F	Max. Allowable Stress for Plates Up to 1 In. Inclusive, Psi
−20 to 150	28,750
200	27,750
300	26,750
400	26,000
500	26,000
600	26,000
650	25,000

Case 1298-1

(*Special Ruling*)

Quenched and Tempered Steel

Par. (4) of the Reply, revise the stress values at 500 and 600 F to read:

26,000

Case 1302

(*Special Ruling*)

Manganese Limit of Grade B Firebox Plates to Specifications SA-201 and SA-212

Inquiry: May manganese in the range of 0.85 to 1.20 per cent be used in Grade B Firebox plates to Specification SA-201 or SA-212 when the impact requirements of SA-300 are imposed?

Reply: It is the opinion of the Committee that it will meet the intent of the Code if material conforming in all other respects to SA-212, Grade B Firebox plates or SA-201, Grade B Firebox plates, has a manganese content in the range of 0.85 to 1.20 per cent, when the impact requirements of SA-300 are imposed.

Proposed Revisions and Addenda to Boiler and Pressure Vessel Code . . .

As need arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Code. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the semi-annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Low-Pressure Heating Boilers, 1959

Par. H-13(a), delete the word "horizontal" in the first line.

Unfired Pressure Vessels, 1959

Par. UHA-11(c), revise to read:

Columbium or columbium plus tantalum may be added to Types 309, 310 and 316 material in an amount not less than 9 times the carbon content and not greater than 1.0 per cent. These materials are designated Types 309Cb, 310Cb, and 316Cb, respectively, in these rules. (See Par. UHA-106 for a suggested restricted composition for Type 316Cb.) The maximum allowable stress values for materials with columbium or columbium plus tantalum added shall be the same as given in Table UHA-23 for Types 309, 310, and 316, respectively.

Par. UHA-106, in the chemical composition, revise reference to columbium to read:

Columbium or Columbium plus Tantalum

0.90 max.	Min. not less than 9 times the carbon content

Par. UA-60

This paragraph has been revised to change definitions of pressure terms. Corresponding revisions have been made throughout the Code to agree with these new terms. (A copy of these revisions may be obtained from the Secretary, ASME Boiler and Pressure Vessel Committee, 29 West 39th Street, New York 18, N. Y.)

Current Engineering Events, News, and Comment

E. S. NEWMAN
News Editor

THE ROUNDUP

Edison Symbol of Technological Age, Says Sarnoff at Unveiling of Bust in N.Y.U. Hall of Fame Ceremonies, June 4, 1961

As Leonardo da Vinci is the immortal symbol of the Italian Renaissance so, in the same sense, is Thomas Alva Edison [Hon. Mem. ASME, 1904] the immortal symbol of our Technological Age, said David Sarnoff.

The chairman of the Radio Corporation of America spoke at a ceremony marking the unveiling of a bronze bust of Edison in the Hall of Fame for Great Americans on the Bronx campus of New York University, June 4, 1961.

"No inventory of his inventions," said Mr. Sarnoff, "can compass the true dimensions of his achievements. Every one of them, even his tentative and uncompleted explorations, became the wellspring of inventions by others. Today, his contributions flow as perpetual tributaries into the main stream of every industry, every science, every technology. Subtract what is Edison's in our current civilization, and the calendar of history would roll backward by decades."

Mr. Sarnoff told how he had been impressed by a sign that Edison had hung on the wall of his laboratory. It said, "There's a way to do it better—find it." "They are so relevant to what I regard as his most vital and enduring contribution. His greatest invention, the one most productive and most instructive for our times, was not a single piece of equipment, but a unique method of innovation. For it was Edison who first conceived the idea of assigning teams of gifted workers to find 'a way to do it better.' In systematizing the quest for new knowledge, he became the father of modern research."

The Father of Modern Research. "At Menlo Park, just 85 years ago this spring, Edison established the world's first industrial research laboratory. He assembled a front-rank technical staff whom he used to refer to as his 'one hundred earnest men,' and whom others nicknamed 'the insomnia squad.'" For his team he set a characteristically demanding goal: "Invent some minor thing every ten days, and some big thing every six months."

The results of that imaginative enterprise are "imperishably" evident, Mr. Sarnoff pointed out and added that some 3000 companies maintain their own research facilities, employing more than 300,000 scientists, engineers, and supporting personnel. A vast number of universities and government agencies are engaged in systematic research. "From the neglected stepchild of industry, research has flourished until it is an industry itself—indeed, our fastest growing industry. This year, in the United States alone, $14 billion will be spent on research and development."

"Research on this formidable scale," said Mr. Sarnoff, "has recast the pattern of national progress. New adaptations of mechanization and automation by re-

Children of Inventor attend ceremonies at N.Y.U. Hall of Fame. Charles Edision, left, son of Thomas Alva Edison, former Governor of New Jersey and former Secretay of the Navy, and his sister, Mrs. Madeleine Edison Sloane, at unveiling on June 4, 1961.

David Sarnoff, **at rostrum,** delivers eulogy honoring Thomas Alva Edison. To his left is Walker L. Cisler, president of the Thomas Alva Edison Foundation and past-president of ASME.

search teams have increased productivity so that the average worker turns out six times as much in an hour as his great-grandfather did. If the present tempo is maintained, workers a century hence will produce as much in a seven-hour day as they now do in a 40-hour week."

"The next ten years," Mr. Sarnoff predicted, "will see more material progress than the last 50 years. Computers, operating a thousand times faster than present models, will take over more and more office and factory chores. Global television in full color, relayed by orbiting satellites, will spread knowledge as Edison's bulb has spread light. Thermoelectric systems, without any moving parts, will heat and cool the home with unexampled efficiency. Electronic tools for medicine will touch off an avalanche of improvements in preventive therapy, diagnosis, and treatment.

"This is only a random sampling of the vast developments now fermenting in hundreds of big and little laboratories, developments that will dwarf those of the past. The surpassing importance of the individual cannot be omitted from the equation of achievement."

Edison's Message. In concluding Mr. Sarnoff said, "Edison's message for our time, as I interpret it, is that we must work as a team, but we must not lose our sense of the uniqueness of man's genius, of the supreme value of the individual. In this lies our best safeguard against the deadly regimentation of communism. It is our best hope for a future of peace, abundance, and freedom."

Mr. Sarnoff is a trustee of the Thomas Alva Edison Foundation which sponsored the ceremony.

The bust of Edison was unveiled by a son and a daughter—Charles Edison, former Governor of New Jersey and former Secretary of the Navy, and Mrs. Madeleine Edison Sloane.

A scratchy recording of Mr. Edison's voice was played at the ceremony. The recording was made Oct. 3, 1908, on the fiftieth anniversary of the first Atlantic cable.

The bust was created by Bryant Baker, whose busts of William Crawford Gorgas and Gen. Thomas J. Jackson are also in the shrine. The Edison bust was the eighty-sixth placed in the open-air colonnade of the Hall of Fame.

PEOPLE

Honors and Awards. William R. Mullee, Mem. ASME, retiring as professor of industrial engineering at New York University, was honored on June 3 at campus ceremonies marking Homecoming Day for the University College of Engineering. Professor Mullee received a plaque at the ceremonies.

Beril Edelman, Mem. ASME, management consultant, received the Alumni Medal of Columbia University's Alumni Federation during the University's Commencement Day ceremonies, June 6. The medal is for "conspicuous Columbia alumni service." Established in 1933, the medal is the Federations's highest award.

Eugene F. Murphy, Assoc. Mem. ASME, has received a citation for meritorious service from the President's Committee on Employment of the Physically Handicapped. Dr. Murphy is chief of the Research and Development Division of the Prosthetic and Sensory Aids Service of the Veterans Administration. Disabled by polio as a child, Dr. Murphy has spent the past 15 years developing and improving a variety of devices such as artificial limbs, braces, hearing aids, and guidance devices for the physically handicapped. He was nominated for the citation by the New York State Governor's Committee on "Employ the Physically Handicapped" in recognition of his contributions to the employability of disabled persons.

Merrill A. Scheil, Mem. ASME, was cited by the University of Wisconsin for his outstanding accomplishments as an engineer, author, and administrator. Mr. Scheil, who is director of metallurgical research with A. O. Smith Corporation, Milwaukee, received the citation on May 5 for his contributions to the advancement of metallurgical engineering.

Walter J. Barrett, special services engineer of the New Jersey Bell Telephone Company, a former president of the American Institute of Electrical Engineers, and former president of United Engineering Trustees, Inc., received the Allan R. Cullimore Award for Distinguished Service on June 8 at the Newark College of Engineering commencement exercises. Mr. Barrett was chiefly responsible, beginning in 1951, for persuading the nation's major engineering societies to consider building the multimillion dollar United Engineering Center now nearing completion in New York City.

● **IN THE UNITED STATES**

July 16–21

Fourth International Conference on Medical Electronics combined with the 14th annual conference on electrical techniques in medicine and biology, sponsored by the AIEE, IRE, and ISA, to be held at the Waldorf-Astoria Hotel, New York, N. Y.

● **IN MEXICO**

August 31–September 12

Electric Power Seminar, including sessions on prospects and problems of nuclear power, sponsored by the United Nations Economic Commission for Latin America and the International Atomic Energy Agency, to be held in Mexico City, Mexico.

● **IN EUROPE**

August 21–31

United Nations Conference on New Sources of Energy; and an industrial-commercial exhibition of equipment showing developments in solar, wind, and geothermal energy fields, organized by Rassegna Internazionale Elettronica, both in Rome, Italy.

MEETINGS OF OTHER SOCIETIES

August 23–26

Institute of Management Sciences, eighth annual international meeting, Palais des Congres, Brussels, Belgium.

September 26–29

International Meeting on Heavy Forging, organized by the Camera di Commercio, Industria e Agricoltura with the co-operation of the Associazione Italiana di Metallurgia, to be held in Terni, Italy.

September, 1961

European Organization for Quality Control, fifth annual meeting, Turin, Italy.

November 13–16

National Maintenance Conference and Exhibition, organized by *Plant and Factory Maintenance*, to be held at The Central Hall, Westminster, London, England.

November 16–25

Hungarian Scientific Society for Mechanical Engineering, International festival of scientific and technical films for mechanical engineering, Budapest, Hungary.

● **IN CANADA**

August 15–18

TAPPI, testing conference, Queen Elizabeth Hotel, Montreal, Que.

October 19–November 7

The Iron and Steel Institute, special meeting in the U. S. and Canada.

● **IN JAPAN**

November 6–11

Society of Chemical Engineers, Japan, 25th anniversary congress exhibition, Sankei Hall, Tokyo, Japan.

(*For ASME Coming Events, see page 102.*)

USAF Event Honors Theodore von Karman on 80th Birthday

Theodore von Karman, Mem. ASME, the free world's senior statesman in the field of the aerospace sciences, was honored on the occasion of his 80th birthday, May 11, 1961, by a symposium sponsored by the Air Force Office of Scientific Research (AFOSR).

The symposium was followed by a dinner which was attended by leaders representing all phases of aerospace activity. Both affairs were held at the Sheraton-Park Hotel in Washington, D. C., under the management direction of the Institute of the Aerospace Sciences. Some 43 national and international scientific and technical societies, the ASME included, together with other organizations with which Dr. von Karman and his work have been identified during his distinguished career, co-operated with the AFOSR in this event.

If only Dr. von Karman's disciples and students had attended the day's events, they would represent a cross section of today's leaders in aerospace educational, military, and industrial affairs. His influence permeates today's thinking in the theory and practice of solid and fluid mechanics and the propulsion sciences.

Dr. von Karman, who is currently chairman of the Advisory Group for Aeronautical Research and Development (AGARD) of NATO and honorary President of the International Council of the Aeronautical Sciences, received tribute for his momentous contributions from a series of eminent speakers.

The banquet featured Under Secretary of the Air Force, Dr. Joseph V. Charyk, as principal speaker. His address was entitled "Toward New Horizons—1961." Dr. Edward Teller, director of the University of California's Radiation Laboratory, acted as toastmaster.

The symposium program, with a morning and an afternoon session, was led by Hugh L. Dryden, Fellow ASME, Deputy Administrator of NASA, and William Sears, director of the Graduate School of Aeronautical Engineering, Cornell University, respectively. At these sessions outstanding technical papers were delivered by Nicholas J. Hoff, Mem. ASME, director of the Department of Aeronautical Engineering, Stanford University; Adolf Busemann, staff scientist, Langley Research Center, NASA; Joseph Kaplan, professor of physics, University of California; and Martin Summerfield, Mem. ASME, professor of aeronautical engineering, Princeton University.

A volume of Proceedings will be published as a commemorative record of the occasion.

Theodore von Karman, Mem. ASME, dean of aerospace sciences, acknowledges applause following introduction by Toastmaster Dr. Edward Teller. The occasion: A dinner held in Washington, D. C., May 11, honoring Dr. von Karman on his 80th birthday. Air Force Office of Scientific Research lectures, also in his honor, were held in conjunction with the dinner. Forty-three national and international scientific and technical organizations co-operated in the function.

Notes on Society Activities and Events

E. S. NEWMAN
News Editor

THE ASME NEWS

West Coast Conference of Applied Mechanics at University of Washington, Aug. 28–30

In the shadow of Mt. Rainier, the annual West Coast Conference of Applied Mechanics will be held on Aug. 28–30, 1961, at the campus of the University of Washington.

This conference is jointly sponsored by the ASME Applied Mechanics Division and the ASCE Engineering Mechanics Division. The joint committee has spent much time to develop a highly informative program. Some of the subjects to be covered are: Plasticity, crack problems, dynamics solids, fluids, elastodynamics, vibrations of solids, shells, beams, and plates.

An interesting inspection trip has been arranged for Tuesday evening, 6:00 p.m., August 29. Boeing Airplane Company will be host, and a tour of the wind tunnels and structural test facilities will be made. Transportation from the compus has been scheduled and dinner will be provided at the plant, courtesy of Boeing.

A regular feature of this conference is the Applied Mechanics Luncheon, and all who plan to be at the conference are urged to attend this event. The luncheon will be held at 12:00 noon on Tuesday, August 29.

For the women scenic tours will be available, and the Registration Desk will provide information regarding recreation, Sight-seeing, places of interest, and so on, for out-of-town visitors.

▶MONDAY, AUGUST 28

General Lecture 9:00 a.m.

On the Construction of Constitutive Equations, by *William Prager*, Brown Univ.

Session 1-A—Plasticity, Thermoelasticity 10:15 a.m.

The Stress Field Produced by Localized Plastic Slip on a Free Surface, by *T. H. Lin* and *T. K. Tung*, Univ. of California at Los Angeles (Paper No. 61—APMW-27)

Elastic-Plastic Design of Rectangular Pressure Tubing, by *R. D. Gauthier*, Dow Chemical Co., Denver, Colo.; and *E. E. Weibel*, Univ. of Colorado (Paper No. 61—APMW-8)

Transient Thermoelastic Problem for an Infinite Medium With a Spherical Cavity Exhibiting Temperature Dependent Properties, by *J. Nowinski*, Univ. of Texas (Paper No. 61—APMW-26)

Session 1-B—Fluid Mechanics 10:15 a.m.

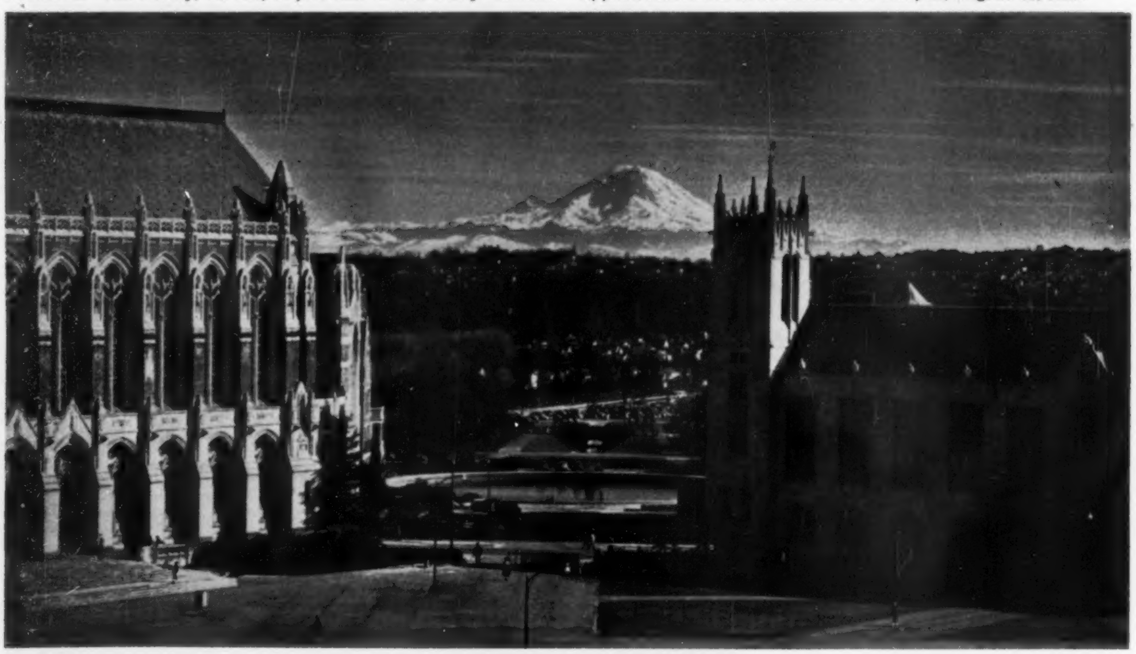
Linearized Transonic Flow About Slender Bodies at Zero Angle of Attack, by *P. F. Maeder*, Brown Univ., and *H. U. Thommen*, General Dynamics Corp., San Deigo, Calif. (Paper No. 61—APMW-12)

Mixing of Compressible Fluids, by *E. D. Kennedy*, General Applied Sciences Labs., Inc., Westbury, N. Y. (Paper No. 61—APMW-3)

An Approximate Analytical Solution for the Stepped Bearings,[1] by *C. F. Kettleborough*, The Univ. of New South Wales, Sydney, Australia (Paper No. 61—APMW-11)

[1] Paper presented by title only.

Mt. Rainier viewed from the quadrangle of the University of Washington in Seattle. The Library, **at left**, is just one of the many facilities available to the conferees attending the West Coast Conference of Applied Mechanics to be held on the campus, Aug. 28–30, 1961.



Availability of Papers by Mail

ALL numbered ASME papers in this program are available in separate copy form until June 1, 1962. Prices are 50 cents to members of ASME, $1 to nonmembers, plus postage and handling charges. Payment may also be made by free coupons, or coupons which may be purchased from the Society in lots of ten at $4 to members; $8 to nonmembers. **You can save the postage and handling charges by including your check or money order made payable to ASME with your order and sending both to: ASME Order Department, 29 West 39th Street, New York 18, N.Y.** Papers must be ordered by the paper numbers listed in this program, otherwise the order will be returned. The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the Conference.

Session 2—Dynamic Solids 2:00 p.m.

On the Application of Variational Methods to Initial Value Problems in Dynamics, by *W. Stuiver,* IBM Research Lab, San Jose, Calif. (Paper No. 61—APMW-21)

Dynamics of Nonholonomic Systems, by *T. R. Kane,* Univ. of Pennsylvania (Paper No. 61—APMW-9)

An Addition to the Theory of Whirling, by *T. R Kane,* Univ. of Pennsylvania (Paper No. 61—APMW-1)

Natural Frequencies of Vibration of Fixed-Fixed Sandwich Beams, by *M. E. Raville, En-Shiuh Ueng,* and *Ming-Min Lei,* Kansas State Univ. (Paper No. 61—APMW-2)

On the Parametric Excitation of Pendulum-Type Vibration Absorber, by *Eugene Sevin,* Illinois Inst. of Tech., Chicago, Ill. (Paper No. 61—APMW-4)

▶TUESDAY, AUGUST 29

Session 3—Elastodynamics 9:00 a.m.

Dynamical Stress Concentration in an Elastic Plate, by *Y. H. Pao,* Cornell Univ. (Paper No. 61—APMW-17)

Wave Propagation in an Elastic Beam or Plate on an Elastic Foundation, by *J. R. Lloyd* and *Julius Miklowitz,* California Inst. of Tech. (Paper No. 61—APMW-25)

Green's Functions for Axially Symmetric Elastic Waves in Unbounded Inhomogeneous Media Having Constant Velocity Gradients, by *J. F. Hook,* Univ. of California, Los Angeles (Paper No. 61—APMW-23)

Load Moving With Super-Seismic Speed Over a Layered Elastic Solid,[3] by *J. L. Sackman,* Univ. of California, Berkeley

Dynamic Membrane Stresses in a Circular Elastic Shell, by *R. G. Payton,* Avco Research and Advanced Development, Wilmington, Mass. (Paper No. 61—APMW-10)

Session 4—Vibration of Solids 2:00 p.m.

Transient Response of a Dynamic System Under Random Excitation, by *T. K. Caughey,* and *H. J. Stumpf,* California Inst. of Tech. (Paper No. 61—APMW-20)

A Note on a New Stability Method for the Linear Modes of Nonlinear Two Degree of Freedom Systems, by *Jack Porter* and *C. P. Atkinson,* Univ. of California, Berkeley (Paper No. 61—APMW-13)

On a Class of Oscillations in the Finite Deformation Theory of Elasticity, by *J. K. Knowles,* California Inst. of Tech. (Paper No. 61—APMW-18)

Dynamic Stability of a Pendulous Missile Suspension System, by *V. Chobotov,* Space Technology Labs, Inc., Los Angeles, Calif. (Paper No. 61—APMW-22)

Analysis for Calculating Lateral Vibration Characteristics of Rotating Systems With Any Number of Flexible Supports, Parts 1 and 2 by *E. C. Koenig, T. G. Guenther,* and *D. C. Lovejoy,* Allis-Chalmers Mfg. Co., Milwaukee, Wis. (Paper No. 61—APMW-16)

[3] Paper contributed by West Coast Committee of ASCE—paper not available in print.

▶WEDNESDAY, AUGUST 30

General Lecture 9:00 a.m.

Variational Considerations in Shell Theory, by *Eric Reissner,* M.I.T.

Session 5-A—Shells 10:15 a.m.

Nonsymmetric Deformation of Dome Shaped Shells of Revolution, by *C. R. Steele,* Lockheed Missiles and Space Div., Sunnyvale, Calif. (Paper No. 61—APMW-19)

On the Buckling of Truncated Conical Shells in Torsion, by *Paul Seide,* Space Tech. Labs., Inc., Los Angeles, Calif. (Paper No. 61—APMW-24)

Out-of-Plane Buckling of I-Section Rings,[3] by *J. E. Goldberg,* Purdue Univ.

Bowing of Cryogenic Pipelines, by *W. F. Flieder,* Arthur D. Little, Inc., Santa Monica, Calif., *J. C. Loria,* Arthur D. Little, Inc., Cambridge, Mass., and *W. J. Smith,* Arthur D. Little, Inc., Santa Monica, Calif. (Paper No. 61—APMW-7)

Session 5-B Dynamic Plasticity, Crack Problems 10:15 a.m.

The Hump Deformation Preceding a Moving Load on a Layer of Soft Material, by *G. R. Abrahamson* and *J. N. Goodier,* Stanford Univ. (Paper No. 61—APMW-5)

Permanent Periodic Surface Deformations Due to a Traveling Jet, by *G. R. Abrahamson,* Stanford Univ. (Paper No. 61—APMW-6)

Dynamic Stresses Created by a Moving Crack, by *B. R. Baker,* Lockheed Missiles and Space Div., Sunnyvale, Calif. (Paper No. 61—APMW-8)

Crack Tip Stress Intensity Factors for Plane Extension and Plate-Bending Problems, by *G. Sih, P. C. Paris,* and *F. Erdogan,* Lehigh Univ. (Paper No. 61—APMW-29)

Session 6—Beams and Plates 2:00 p.m.

On Beams of Elastic Foundations, by *F. Essenburg,* Illinois Inst. of Tech. (Paper No. 61—APMW-14)

Bending of Beams Resting on an Elastic-Isotropic Solid,[3] by *Aleksander Vesic,* Georgia Inst. of Tech.

Bending of Plates on an Elastic Foundation, by *K. S. Pister* and *R. A. Westmann,* Univ. of California, Berkeley (Paper No. 61—APMW-15)

Viscoelastic Foundatipn of the Winkler Type With Shear Interaction,[3] by *A. D. Kerr,* New York Univ.

A Method for Analyzing Axisymmetric Flat Plates With Complicating Conditions, by *J. E. Brock,* U. S. Naval Postgraduate School, Monterey, Calif. (Paper No. 61—APMW-30)

Hydraulics Specialists Convene at Joint ASME-EIC Conference in Montreal

Prime movers, fluid mechanics, cavitation, hydrology and ice, compressors, among subjects discussed

THE Joint Hydraulics Conference, Queen Elizabeth Hotel, Montreal, Que., Canada, May 8–11, 1961, of The Engineering Institute of Canada and The American Society of Mechanical Engineers was distinguished not only for the heavily theoretical content of the 36 papers presented in dual concurrent sessions, but for the availability of preprints on every EIC and ASME paper.

On the theoretical side there were five fluid mechanics sessions and one each on cavitation and water hammer.

Only one ASME paper described a prime-mover application—the high-head Francis turbines for the Mammoth Pool Hydroelectric Project of Southern California Edison Company on the upper San Joaquin River near Fresno. Rated at 88,000 hp under 950 ft net head at 360 rpm, these 110-in-diam turbines are the largest high-head Francis units in the United States. They were chosen in place of impulse turbines because they made a higher speed generator and increased head possible. Construction-cost savings were about $600,000 and there were operating economies as well.

An EIC paper described some of the major design considerations for penstocks on two recent high-head projects. The Kundah Hydro Electric Project in the west of Madras State, India, will utilize a head of over 5000 ft in several stages. The project came under the Canadian aid program of the Colombo Plan Administration. The Spray Hydro Electric Project located near Canmore, Alta., Canada, has a gross head of 900 ft.

Another EIC paper reviewed research developments on the Bulb turbine (MECHANICAL ENGINEERING, February, 1960, pp. 96–97) and its application to river and tidal power plants. Data were given on the four high-output bulb-unit plants in operation in France.

The design problems in the condenser circulating-water system for Ontario Hydro's mammoth (1,800,000 kw with ultimate capacity of possibly 2,400,000 kw) Lakeview steam-power plant in Toronto were described.

Appropriate to the Canadian location of the conference was a group of papers on hydrology and ice, concerned with the particular problems of designing and operating hydroelectric and other river

or lake-situated structures where seasonal ice creates special conditions. Not only was it necessary to build frazil-ice protection into the Lakeview Generating Station, but the formation of ice covers on rivers affects the operations of the Quebec Hydroelectric Commission. Ice jams in Montreal Harbor have been responsible for surelevations of 30 ft or more. Wind-induced upper-layer circulation and subsequent ice-drift phenomena in the Gulf of St. Lawrence also were studied. Even the transfer of heat from a river to an ice sheet has its place in Canadian engineering calculations.

Mechanical engineers in Canada also are attempting to replace "sleight-of-hand mathematics" and define precisely what is meant by "cost" and "benefit" when evaluating flood-control and water-conservation schemes. It is desirable also to describe flood damages statistically.

Wave energy and its relation to silt deposition occupied the attention of two papers. One was on the mechanism of sediment movement, another on the use of submerged breakwaters to reduce silt deposition in a harbor.

Locale and composition of the conference also were reflected in the guest speaker's topic at the Organized ASME-EIC Luncheon (there was no banquet). Andrew Collard, editor of the *Montreal Gazette* spoke on "Americans' Montreal." EIC President George McKinstry Dick and ASME President William H. Byrne also spoke briefly. Robert C. Dean, Jr., secretary of the ASME Hydraulic Division, presided.

ASME Officers Nominated for 1962

Members of the ASME Nominating Committee for 1961: W. E. Belcher, Jr., *chairman;* J. R. Muenger, *secretary;* C. G. Parker; Erskine Vandergrift; R. I. Holloway, Jr.; E. W. Jerger; D. B. Chenoweth; R. B. Stewart; J. W. MacPherson; R. G. Critz; N. J. Hoff; Z. R. Bliss; and F. K. Mitchell, have nominated for 1962 the following:

Office	Nominee
President	Clifford H. Shumaker
Vice-President (for two years)	Edward Walton, Region I
	Robert William Worley, Region III
	Robert Nelsen, Region V
	Niles Hutton Barnard, Region VII
	Emmett Elbert Day, Region IX
	Thomas Jackson Judge, Region XI
Directors (for four years)	Ernst W. Allardt
	George M. Muschamp
	John Parmakian
(for two years)	Robert Chester Allen

Availability List—ASME-EIC Hydraulic Conference

ASME Papers

The papers in this list are available in separate copy form until March 1, 1961. Please order only by paper number; otherwise the order will be returned. You can save the postage and handling charges by including your check or money order made payable to ASME with your order and sending both to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 50 cents each to members; $1 to nonmembers. Payment also may be made by free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten are $4 to members; $8 to nonmembers.

61—Hyd-1 Cavitation Tests on Hydrofoils Designed for Accelerating Flow Cascade, Report 1, by F. Numachi

61—Hyd-2 Surges in Air Vents Adjacent to Emergency Gates, by I. W. McCaig and F. H. Jonker

61—Hyd-3 Complete Pump Characteristics and the Effects of Specific Speeds on Hydraulic Transients, by B. Donsky

61—Hyd-4 A Preliminary Study of Turbulence Characteristics of Flow Along a Corner, by F. B. Gessner and J. B. Jones

61—Hyd-5 Friction Drag on Bladed Disks in Housings as a Function of Reynolds Number, Axial and Radial Clearance, and Blade Aspect Ratio and Solidity, by R. W. Mann and C. H. Marston

61—Hyd-6 A Correlation of Fan Performance for Solving Selection Problems, by N. J. Lipstein

61—Hyd-7 Adiabatic Flow of Flashing Liquids in Pipes, by M. Sajben

61—Hyd-8 On the Mechanism of Cavitation Damage by Nonhemispherical Cavities Collapsing in Contact With a Solid Boundary, by C. F. Naude and A. T. Ellis

61—Hyd-9 The Phase-Plane Topology of the Simple Surge-Tank Equation, by A. W. Marris

61—Hyd-10 Vibration of Vertical Pumps, by A. Kovats

61—Hyd-11 An Experimental Study of Vortex Chamber Flow, by J. P. Holman and G. D. Moore

61—Hyd-12 A Flow Model for Two-Phase Slug Flow in Horizontal Tubes, by E. S. Kordyban

61—Hyd-13 An Experimental Investigation of the Use of Supersonic Driving Jets for Ejector Pumps, by R. V. Deleo, R. E. Rose, and R. S. Dart

61—Hyd-14 Generalized Multistage Axial Compressor Characteristics, by G. L. Mellor and T. Root

61—Hyd-15 Experimental Investigation of Subsonic Turbulent Flow Over Single and Double Backward Facing Steps, by D. E. Abbott and S. J. Kline

61—Hyd-16 Hydroelastic Vibrations of Flat Plates Related to Trailing Edge Geometry, by G. H. Toebes and P. S. Eagleson

61—Hyd-17 Nonsteady Supercritical Discharge Through an Orifice, by G. Rudinger

61—Hyd-18 Characteristics of Helical, Rotary, Positive Displacement Compressors, by K. E. Wichert

61—Hyd-19 Problems of Predicting Cavitation Erosion From Accelerated Tests, by J. M. Hobbs

61—Hyd-20 Local Liquid Distribution and Pressure Drops in Annular Two-Phase Flow, by H. N. McManus, Jr.

61—Hyd-21 High-Head Francis Turbines for Mammoth Pool, by L. Brown

EIC Papers

All EIC papers in this list are available in separate copy. Prices are 50 cents to members of EIC and $1 to nonmembers, plus postage and handling charges. You can save the postage and handling charges by including your check or money order and sending it along with your request to: EIC Technical Papers Order Department, 2050 Mansfield Street, Montreal 2, Que., Canada. Papers must be ordered by the paper numbers listed in this list, otherwise the order will be returned.

61—EIC-1 The Effect of Secondary Currents Upon the Capacity of a Straight Open Channel, by R. J. Kennedy and J. F. Fulton

61—EIC-2 Effect of High Velocities on Turbine Pitting, by F. L. Lawton and M. D. Lester

61—EIC-3 Flow of Water Through a Force Field in a Soil-Water System, by R. Yong and O. J. Frenkel

61—EIC-4 On the Transfer of Heat From a River to an Ice Sheet, by W. D. Baines

61—EIC-5 Measures of Value and Statistical Models in the Economic Analysis of Flood Control and Water Conservation Schemes, by D. J. Clough

61—EIC-6 Formation and Evolution of Ice Covers on Rivers, by E. Pariset and R. Hausser

61—EIC-7 The Use of Wave Energy to Reduce Silt Deposition in a Harbor, by B. LeMéhauté and J. Cowley

61—EIC-8 The Effect on Mass-Transport of the Onset of Turbulence at the Bed Under Periodic Gravity Waves, by A. Brebner and J. I. Collins

61—EIC-9 Parallel Development of Open-Channel Flow and Gas Dynamics, by T. Blench

61—EIC-10 Design of High-Head Penstocks, by W. J. Smith

61—EIC-11 Moving Hydraulic Jumps in Fluidized Solids Systems, by R. W. Ansley and R. H. B. Hebbert

61—EIC-12 The Quest for the Ultimate in the Interpretation of Experimental Data—An Engineering Challenge, by L. E. Jones

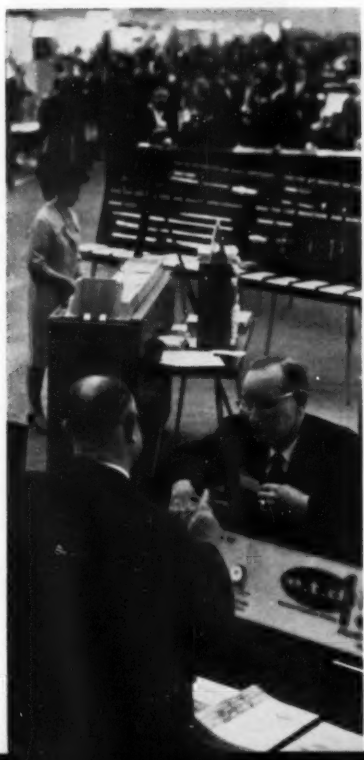
61—EIC-13 Research Developments and Results Concerning Bulb Units—Applications to River and Tidal-Power Plants, by S. X. Casacci, J. P. Duport, and E. F. Pariset

61—EIC-14 Design Problems in Condenser Circulating Water System for Lakeview Generating Station, by J. T. Weichowski

61—EIC-15 Note on the Wind-Induced Upper Layer Circulation and Subsequent Ice-Drift Phenomena in the Gulf of St. Lawrence, by G. E. Jarlan

Designing for Today's Competitive Market

Panel discussion highlights ASME Design Engineering Conference



The Conferees heard. . ."OUR MAIN interest is to build long life into cars," said Will Scott, who is in charge of Ford Motor Company's central production planning office, in an effort to dispel the notion that the life of a car is predetermined by the manufacturer. Engineers are working constantly to develop cars which will run 100,000 miles without a major overhaul or failure.

Manufacturers are reviewing their automobiles part-by-part to eliminate potential trouble spots, Scott further added.

"It is industry's responsibility to minimize the cost of maintenance and we are making progress that the public can feel in its pocketbook," said Scott. "We realize that the cost of making a part right in the first place is only a small fraction of replacing or repairing it after the car is sold."

Mr. Scott said there is no "rebellion" against Detroit's product among consumers. American manufacturers can beat foreign competition through good designing.

"Auto prices are not too high for the quality, styling, and reliability of today's products," Scott stated. "American manufacturers do not need tariff protection against foreign competition."

"There is no conflict in an automotive company's producing different size cars. Cars serve different purposes to meet these differing needs," he said.

The single automobile is no longer a status symbol, Scott pointed out. "The number of cars a family owns today is the test. The really affluent family is the one that has so many cars they occasionally misplace one or lose it."

Carl E. Burke, chief development engineer of American Motors Corporation, said the popularity of compact cars is the low maintenance cost. He said the automotive suppliers are making the greatest contributions to car design. "They are specialists in their own field and the component parts they design determine the quality of the car."

H. M. Bevans, executive engineer, chassis, electrical, truck section, of Chrysler Corporation warned that the increasing use of salt to melt snow, side-by-side with unitized production of cars, presents a major corrosion problem. American manufacturers, he said, are trying to deal with the problem of rust proofing their cars so that "cars do not rust and fold up in the middle."

Commenting on model changes Mr. Bevans added that "although engineers thrive on change, automobile companies resist change for the change's sake." An improvement must improve car reliability and interest new customers," he said.

Also speaking about model changes, C. F. Orloff, assistant chief engineer, production engineering department, Chevrolet Motor Division of General Motors, pointed out that intense competition within the industry required that companies stay abreast of the market by hav-

Opening-day panel audiences arrived early and stayed late, joined the lively discussion that followed. They heard four leaders in the automotive industry tell how their

ing the latest in design. Shorter "lead time" in making changes is essential, he added.

"To stay competitive, a manufacturer needs a shorter lead time from planning to production in order to incorporate improvements. At the same time, lead time cannot be too short, or crash programs will force tooling costs and car prices too high," he said.

During the question period that followed it was revealed that warranties might be extended even further; that corrosion control is being combated with paint dipping, galvanized steel door sills, and the like. The panel agreed that safety is designed into all cars; but they stressed that a safety belt, an added precaution, is of no use if not worn. Never has there been a car built that will be safe in a head-on collision at 75 mph or that hits a tree at 80 mph.

Thus the 1961 ASME Design Engineering Conference opened in Cobo Hall, Detroit, Mich., May 22. More than 1100 engineers attended the conference that covered everything new from manufacturing—key to saving, automatic equipment, glass and ceramics, high-strength steel, motors, production, adhesives, cost analysis, plastics, dynamics, to lubrication.

Digests of the technical session papers, of which there were 22, appeared in the May, 1961, issue of MECHANICAL ENGINEERING, pp. 154–156. (Also see the Availability List of papers on page 100 of this issue.)

Honors and Awards. Not only was it a first for the Design Engineering Conference to be in Detroit, but for the first time a formal luncheon was held in conjunction with the Conference.

R. G. LeTourneau, Fellow ASME, pioneer builder of giant earth-moving equipment, received the Society's Machine Design Award. He was cited for "outstanding achievement and distinguished service in the field of machine design." Orlon W. Boston, Fellow ASME, professor-emeritus of mechanical and production engineering, University of Michigan, re-

Design Engineering Show

Some views of the Design Engineering Show held at Cobo Hall, Detroit, Mich., May 22–26. More than 18,000 engineers and their guests visited, inspected, and had demonstrations of products—some applications so new, that no one knew just what they were for—at 400 different booths. The products were valued at $10 million by the exhibitors. 1 Some of the crowds who poured in to find how the gadget works. 2 Huge chain belt was just one of some 15,000 new ideas. 3 A car which runs at high speeds on a monorail between cities, but also runs on conventional roadways. 4 Some are hard to convince. . . it may not be a revolutionary break-through in graphite metals technology, but the process combines varying amounts of graphite with metal.

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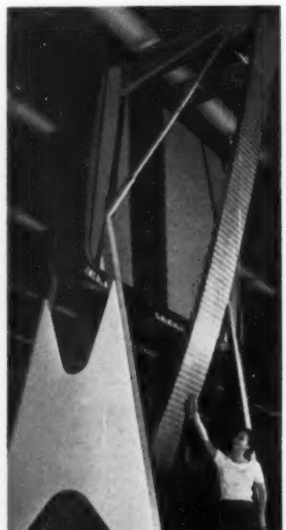

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companies design to meet today's competitive market. During the four-day ASME Design Engineering Conference and Show at Cobo Hall, the interest never flagged.

ceived a certificate of appreciation for developing standards in the field of small tools and machine-tool elements. ASME President W. H. Byrne presented the awards; he told of the benefits engineers derive from the show and conference.

What Engineers Should Do. Engineers must stop concentrating their efforts on mechanical improvements and start to concern themselves with the economic significance of change, Alan Mattison, immediate past-president of the National Machine Tool Builders Association, told engineers attending the Design Engineering Luncheon.

"Our world is changing fast and it is the engineer's world," declared Mr. Mattison, president of Mattison Machine Works, Rockford, Ill. "Competition is no longer restricted to businesses and markets. It has become a factor in national prestige and world politics. With greater understanding of economics by engineers, and greater appreciation of engineering by economists, there is a tremendous opportunity for growth."

Mr. Mattison called for a "strengthened complex of superior research and engineering—a complex that is strengthened by an increasing share of scientific data generated by our national scientific and defense programs. A complex that is privately financed through pooled research in small-company industries. And, a complex that is vitalized continuously by the effective working methods of those of us who are a part of this important field of engineering.

"One of the big problems, both from an economic and individual company standpoint, is foreign competition," pointed out Mr. Mattison.

"Why should a foreign machinery builder, who derives his chief competitive advantage in this country—low price—from the fact that he exists in a low labor-rate economy, be able to sell his products in this country? Should machinery designed for a low labor-rate economy be competitive in a country which has a high labor rate? Doesn't this simply

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prove that we have fallen behind in our engineering?

"There is a particular lesson here for engineers. We must stop concentrating on mechanical things. We must see through things to their economic significance."

What They Saw . . . Ten million dollars worth of exhibits, products, and displays were shown in Cobo Hall by 400 exhibiting companies during the Design Engineering Show, which attracted 18,000 visitors from all parts of the world.

Staged by Clapp & Poliak, Inc., of New York City, the show has come to be regarded as the annual showcase where the year's results of work in the nation's research and development laboratories are displayed. Some 4000 technical experts were on hand to answer visitors' questions. More than 15,000 product ideas were shown and demonstrated by exhibitors. Outstanding were: A lawn mower casing made of one piece of plastic which makes it virtually vibrationless, rustproof, and much quieter; a solar engine which converts the heat of the sun directly into rotary motion; a light which can be buried in a landing strip and provide pilots with a guide line for nose cone wheels to supplement side lights; the costliest cloth in the world ($500 per sq ft)—made of stainless-steel wire—and used in parachutes which drop space capsules; a "piggyback" automobile which rides like a conventional car, but is mounted on a monorail for intercity travel; decorative trim for appliances and autos, made of steel foil, which can be applied simply by the hand's pressure and requires no mechanical fastening; a pump capable of producing 500,000 psi; a delicate gage which can measure the difference between the weight of a paper before and after it is written upon; a new building material unaffected by moisture, 100 per cent incombustible, and rot and decay-proof; plastic shafts for golf clubs; ball bearings of ceramics and plastics, as well as metallic materials.

Availability List—Design Engineering Conference

The papers in this list are available in separate copy form until March 1, 1962. Please order only by paper number; otherwise the order will be returned. You can save the postage and handling charges by including your check or money order made payable to ASME with your order and sending both to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 50 cents each to members; $1 to nonmembers. Payment also may be made by free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $4 to members; $8 to nonmembers.

61—MD-1 Producibility — Designing for Production, by C. E. Warner and R. L. Berg

61—MD-2 Materials Standardization to Reduce Costs, by G. L. Swartwood

61—MD-3 Special Requirements of Hydraulic Systems for Tape-Controlled Machinery, by R. K. Sedgwick

61—MD-4 Which Drive—Electric, Mechanical, or Hydraulic? by G. W. Younkin

61—MD-5 Ceramic Materials: A Chemical and Structural Description, by M. G. Britton

61—MD-6 What Do Glasses and Ceramics Offer the Design Engineer? by J. R. Blizard

61—MD-7 Recent Developments in High-Strength Steels, by R. A. Lula

61—MD-8 Impact of Recent Developments in High-Strength Steels on Structural Design and Fabrication, Part 2—Design and Fabrication, by R. H. Marvin

61—MD-9 Electric Motors at Higher Temperatures for Industrial Usage, by F. C. Rushing

61—MD-10 Mechanical Application of Nonexcited Synchronous Motors, by J. P. Landis

61—MD-11 Design Techniques for Simplified Programming of Numerically Controlled Machine Tools, by A. Taleff

61—MD-12 Cost and Value of Small Tolerances and Smooth Finishes, by W. W. Gilbert

61—MD-13 Elastomeric Adhesives . . Industry's New Tool, by W. C. O'Leary

61—MD-14 Factors in Joint Design Using Adhesives for Metal Bonding, by H. R. Butzlaff and K. F. Charter

61—MD-15 Which Fastener Should We Choose? by J. W. Stoutenburg and K. D. Ringland

61—MD-16 Designing With Powder Metallurgy to Improve Quality and Reduce Costs, by P. J. Failla

61—MD-17 Filament-Wound Pressure Vessels, by R. Gorcey

61—MD-18 An Introduction to Designing With Plastics, by R. L. Thorkildsen and J. V. Schmitz

61—MD-19 Viscoelastic Damping, by D. K. Hatch and C. H. Adams

61—MD-20 Effect of Misalignment of Tooth Action of Bevel and Hypoid Gears, by M. L. Baxter, Jr.

61—MD-21 Molybdenum Disulfide as a Lubricant, by K. B. Wood, Jr.

61—MD-22 Molybdenum Disulfide as an Additive to Improve the Performance of an Automotive Multipurpose Grease, by C. D. Thayer and H. G. Rudolph, Jr.

Production Engineering Conference Stresses International Co-Operation for Productivity

The Fourth Annual Conference, sponsored by the ASME Production Engineering Division, was held in Toronto, May 9 to 12, inclusive. The theme was "International Co-operation for Productivity." Co-operating in the arrangements were the ASME Ontario Section, The Institution of Production Engineers of the United Kingdom, and the Engineering Institute of Canada.

Keynote Session. The first speaker, H. A. Wallace, vice-president—manufacturing, Massey-Ferguson, Ltd., told how production engineering was directed in a company having 27 separate manufacturing facilities spread widely over the world. David L. Nicolson, managing director, Production Engineering, Ltd., London, England, described the factors involved in planning and designing factories on an international scale to provide for new methods and the needs of employees. Markets for proposed products, plant locations, and availability of the desired labor were discussed. A glimpse into the future of productivity was undertaken by W. F. S. Woodford, Secretary, The Institution of Production Engineers. His forecast covered such factors as the extension of automatic production and the ensuing use of leisure time. Frederick S. Blackall, jr., past-president of ASME, presided at the keynote session.

International Panels. Two international panel sessions were designed to bring into focus some of the problems faced by the metalworking industry in the utilization of numerically controlled production equipment. The first, with W. W. Gilbert, Mem. ASME, General Electric Company, acting as moderator, discussed methods of programming and data preparation. German practice in this regard was described by Dr. Ing. Herwert Opitz, director, Laboratory for Machine Tool and Management Service, Institute of Technology, Aachen, Germany.

The second panel session was moderated by J. M. Morgan, chief engineer, Cimtrol Division, Cincinnati Milling Machine Company. Panelists reported on the things needed for preparing and utilizing the information needed to operate self-controlling machine tools.

In addition, 24 technical papers were presented. These covered international experience on tool wear, computer controls, metal-cutting analysis, optical alignment of machine tools, abrasive belt and grinding wheels, systems and materials handling, and the economics of cutting tools.

ASME President W. H. Byrne addressed the ASME Ontario Section Dinner and took this occasion to stress the strong ties between engineers from the United States and Canada. He pointed out that, perhaps these ties are simply an outgrowth of the economic co-operation between the two. The fact, he added, that to a large extent we share a common culture, and to the frequently cited fact that we share the longest unfortified border in the world.

Left Photo. ASME Production Engineering Conference Committee whose co-operation helped make the meeting in Toronto so successful. They are: A. D. Hogg, D. F. Quan, Dick Quan, J. W. Miller, Walter Kootow, J. B. Adams, H. A. Williams, and Stanley Carroll of The Institution of Production Engineers. **Right Photo.** Key figures and keynote speaker at ASME Production Engineering Conference, Royal York Hotel, and National Production Show. **Left to right:** J. W. Miller, General Arrangements Chairman; H. A. Wallace, vice-president—manufacturing and director, Massey-Ferguson Ltd., keynote speaker; and Dr. A. O. Schmidt, chairman, ASME Production Engineering Division.

"I like to think," Mr. Byrne said, "that these ties represent something a little bit bigger than that, the fact that we recognize that by working together and sharing our knowledge we can help not only the other fellow, but help ourselves. I hope that we never lose sight of this basic truth, especially in the dust that is sometimes raised by petty problems. I hope, as I am sure you do, that this strong spirit of sharing and co-operation will continue to grow in our relations with other countries in this hemisphere and abroad."

Conference activities were directed by A. O. Schmidt, chairman, ASME Production Engineering Division and Sir John W. Miller, chairman of the General Arrangements Committee.

The Production Engineering Division luncheon was addressed by F. J. Lyle, director of industrial development, Department of Commerce and Development, Province of Ontario. Mr. Lyle outlined the advantages of manufacturing arrangements between foreign manufacturers and Canadian plants.

ASME members and guests attending the conference had the opportunity of visiting the National Industrial Production Show of Canada, which was held concurrently with the Production Engineering Conference, at the Canadian National Exhibition Park.

Availability List—Production Engineering Conference

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61—Prod-1 Metal-Cutting Analysis, Part 1, Re-Evaluation and New Method of Presentation of Theories, by S. Kobayashi and E. G. Thomsen

61—Prod-2 Metal-Cutting Analysis, Part 2, New Parameters, by S. Kobayashi and E. G. Thomsen

61—Prod-3 Flank Friction Studies With Carbide Tools Reveal Sublayer Plastic Flow, by E. G. Thomsen, A. G. MacDonald, and S. Kobayashi

61—Prod-4 Free Machining Steel, Part 4, Tools With Reduced Contact Length, by E. Usui and M. C. Shaw

61—Prod-5 A Graphical Analysis of Regenerative Machine-Tool Instability, by J. P. Gurney and S. A. Tobias

61—Prod-6 Strain-Rate Distribution During Experimental Metal Rolling, by K. S. Yajnik and J. Frisch

61—Prod-7 Comparative Effect of Land and Crater Wear on Tool Life When Dry Cutting, Mist Cooling, and Flood Cooling, by D. Kececioglu and A. S. Sorensen, Jr.

61—Prod-8 On Determining the Hardness of Grinding Wheels, Part 1, by L. V. Colwell, R. O. Lane, and K. N. Soderlund

61—Prod-9 Use of Abrasive Belts and New Applications, by D. H. Knapp, Jr.

61—Prod-10 How to Measure Machine-Tool Capabilities, by R. B. Nottingham and J. Ralph

61—Prod-11 How to Verify an Optical Instrument's Accuracy, by A. W. Young

61—Prod-12 A Review of Metal-Processing Literature Metal-Cutting Analysis, by J. S. Campbell, S. Kobayashi, J. M. Galimberti, R. S. Hahn, and E. G. Thomsen

61—Prod-13 On the Benefits of High-Modulus, High-Density Boring-Bar Structures, by W. L. Kennicott and J. J. Galimberti

61—Prod-14 Diamond Cutting Tools Engineered for Production, by J. Taeyaerts

61—Prod-15 Optical Check Out of Large Machine Tools, by G. W. Donald

61—Prod-16 International Progress in the Planning and Design of Factories, by D. L. Nicolson

61—Prod-17 Measuring Material Handling Work, by J. A. Brown

61—Prod-18 International Productivity Co-Operation in the Future, by W. F. S. Woodford

61—Prod-19 Management-Operating System, by R. N. Easun and R. C. Carroll

International Developments in Heat Transfer Basis of Discussions in Boulder, Aug. 28–Sept. 1, 1961

The final arrangements for the Second International Heat Transfer Conference were completed at a meeting of the American Conference Committee held in Chicago, Ill., on May 12, 1961. The five-day conference, August 28 to September 1, 1961, will bring to the University of Colorado at Boulder, Colo., an international gathering of engineers and scientists for discussions on the general theme, "New Developments in Theory and Practice." Through the combined efforts of the sponsoring and participating organizations, approximately 125 papers will be available for discussion from the United States, United Kingdom, Canada, Japan, USSR, Switzerland, Australia, Italy, Germany, Sweden, and Yugoslavia.

The conference is sponsored by The American Society of Mechanical Engineers, American Institute of Chemical Engineers, The Institution of Mechanical Engineers, The Institution of Chemical Engineers with the participation of the American Chemical Society, The American Nuclear Society, American Rocket Society, American Society of Heating, Refrigeration and Air-Conditioning Engineers, The Chemical Institute of Canada, The Engineering Institute of Canada, Institute of the Aerospace Sciences, Society of Automotive Engineers, University of Colorado, and the co-operation of the ASME and AIChE Rocky Mountain Sections.

Four special lectures by outstanding engineers, from the United States and Europe, will be given during the conference. A series of luncheons, banquet, and other social activities have been arranged by the local committee including special events for the women.

Advance Registration is urged by the committee. Full information on registration and advance program may be obtained from Meetings and Divisions Department, ASME, 29 West 39th Street, New York 18, N. Y.

The annual ASME Heat Transfer Conference has been combined with this international conference.

Extreme Temperature Lubrication

Specialists of ASME's Lubrication Division meet at Miami Beach for the 1961 Spring Lubrication Symposium

The annual Spring Lubrication Symposium of The American Society of Mechanical Engineers took place May 8–10, 1961, at the Deauville Hotel in Miami Beach, Florida. This is the first time that ASME has scheduled a Conference in Florida, and results were gratifying. There were more than 170 registrants for this highly specialized symposium: Of this number, 30 were women who accompanied their husbands to one of the loveliest beaches in the world.

In the past, the Lubrication Symposium has been a Conference in which advanced ideas were brought out in informal discussion, ideas not yet ready for formalizing in technical papers.[1] In the future, the Symposium will return to this format. But at Miami Beach, 27 technical papers had been prepared and were presented. The opening lines of one of these papers give a clear indication of the problems faced: "Present-day lubricants and hydraulic fluids for high-performance aircraft are required to operate over increasingly wider ranges of temperatures. Extension of the upper temperature limit, which is imperative for operation of these vehicles, causes a severe problem in maintaining low-temperature capabilities of fluids."

Sessions covered "Hydrodynamic Lubrication," "Fluid Film Bearings," "Lubrication With Inorganic Lubricants," "Research Techniques," "High-Temperature Friction and Wear," and "Extreme-Temperature Bearings."

The man most instrumental in bringing about the Society's first national meeting in Florida was Brig. Gen. T. A. Weyher, Mem. ASME, and Dean of Engineering, School of Engineering, at the University of Miami in Coral Gables. Dean Weyher made an address of welcome at one of the early sessions. It was notable that this Conference at Miami Beach experienced an uncommonly high ratio of attendance at technical sessions—up to 70 per cent of the total registration. The smooth and efficient operation of the entire Conference was due in large part to the work of the local General Arrangements Committee, S. S. Rocklin, Chairman.

To Mrs. Rocklin goes credit for the women's program which included a tour of the Lincoln Road Mall, a boat trip on the Inland Waterway and Biscayne Bay, and visits to the famous Vizcaya Museum and the Seaquarium. On the evening of the second day of the Conference, there was a Hawaiian luau at the hotel. The general program did not include a banquet or any official luncheons.

Essentially, this was a Conference of six technical sessions and 27 papers, on a most exacting phase of mechanical-engineering development. One of the papers, "Externally Pressurized Gas Bearings," by H. C. Rothe, appeared in condensed form as a feature article in Mechanical Engineering, June, 1961, pp. 45–48.

[1] In the 1958 Symposium, presentations and discussions on viscosity contributed to the knowledge of viscosity both in theory and service applications. ASME has just published them in a book entitled, "The Role of Viscosity in Lubrication." Price, $4.50 (20 per cent less to ASME members).

Availability List—Lubrication Symposium

The papers in this list are available in separate copy form until March 1, 1962. Please order only by paper number; otherwise the order will be returned. You can save the postage and handling charges by including your check or money order made payable to ASME with your order and sending both to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 50 cents each to members; $1 to nonmembers. Payment also may be made by free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $4 to members; $8 to nonmembers.

61—LubS-1 A Solution of Reynolds Equation for a Full Finite Journal Bearing, by S. Ramachandra

61—LubS-2 Journal Bearings With Arbitrary Position of Source, Part 2, by J. V. Fedor

61—LubS-3 Rolling-Contact Fatigue Studies With Four Tool Steels and a Crystallized Glass Ceramic, by E. V. Zaretsky and W. J. Anderson

61—LubS-4 Externally Pressurized Gas Bearings, by H. C. Rothe

61—LubS-5 Mechanisms of Boundary Lubrication/Boundary Lubrication of Copper, Mild Steel, and Stainless Steel During Severe Cold Deformation, by P. R. Lancaster and G. W. Rowe

61—LubS-6 Nonrotating Journal Bearings Under Sinusoidal Loads, by R. M. Phelan

61—LubS-7 Squeeze Films: A Finite Journal Bearing With a Fluctuating Load, by D. F. Hays

61—LubS-8 Externally Pressurized Step Journal Bearings, by C. R. Adams, J. Dworski, and E. M. Shoemaker

61—LubS-9 Evaluation of Unconventional Lubricants at 1200 F in High-Speed-Rolling Contact Bearings, by D. S. Wilson

61—LubS-10 Low-Temperature Pumpability of Experimental Lubricating Fluids, by L. R. Drane and V. Hopkins

61—LubS-11 The Lubrication of Ball Bearings With Solid Films, by M. J. Devine, E. R. Lamson, and J. H. Bowen, Jr.

61—LubS-12 Phase Plane Analysis of Dynamically Loaded Journal Bearings, by H. T. Albachten

61—LubS-13 Air Lubrication—A Development Tool, by M. L. Levene

61—LubS-14 The Use of Free-Energy Relationships in the Selection of Lubricants for High-Temperature Applications, by F. K. Orcutt, H. H. Krause, and C. M. Allen

61—LubS-15 Friction and Wear Behavior of Refractory Materials at High Sliding Velocities and Temperatures, by L. B. Sibley and C. M. Allen

61—LubS-16 Frictional Behavior of Sodium-Lubricated Materials in a Controlled High-Temperature Environment, by J. W. Kissel, W. A. Glaeser, and C. M. Allen

61—LubS-17 Boric Oxide as a High-Temperature Lubricant, by E. Rabinowicz and M. Imai

61—LubS-18 Testing of Ball Bearings With Five Different Separator Materials at 9200 Rpm in Liquid Nitrogen, by J. A. Brennan, W. A. Wilson, R. Radebaugh, and B. W. Birmingham

ASME COMING EVENTS

August 28–30, 1961

ASME West Coast Conference of Applied Mechanics, University of Washington, Seattle, Wash.

August 28–September 1, 1961

Second International Heat Transfer Conference, University of Colorado, Boulder, Colo.

September 14–15, 1961

ASME-AIEE Engineering Management Conference, Hotel Roosevelt, New York, N. Y.

September 24–27, 1961

ASME-AIEE National Power Conference, St. Francis Hotel, San Francisco, Calif.

September 24–27, 1961

ASME Petroleum Mechanical Engineering Conference, Muehlebach Hotel, Kansas City, Mo.

October 4–6, 1961

ASME Process Industries Conference, Shamrock Hilton Hotel, Houston, Texas

October 17–18, 1961

ASME Bulk Solid Handling Symposium, Pick Nicollet Hotel, Minneapolis, Minn.

October 17–19, 1961

ASME-ASLE Lubrication Conference, Morrison Hotel, Chicago, Ill.

November 26–December 1, 1961

ASME Winter Annual Meeting, Statler Hilton Hotel, New York, N. Y.

January 24–26, 1962

ASME Second Symposium on Thermophysical Properties, Princeton University, Princeton, N. J.

March 4–8, 1962

ASME Gas Turbine-Process Industries Conference and Products Show, Shamrock Hilton Hotel, Houston, Texas

April 5–6, 1962

ASME-SAM Management Engineering Conference, Statler Hilton Hotel, New York, N. Y.

April 9–13, 1962

ASME Metals Engineering Division—AWS Conference, Sheraton Cleveland Hotel, Cleveland, Ohio

April 10–11, 1962

ASME-AIEE Railroad Conference, King Edward Hotel, Toronto, Canada

April 30–May 3, 1962

ASME Design Engineering Conference and Concurrent Show, Chicago Exposition Center, Chicago, Ill.

May 7–8, 1962

ASME Maintenance and Plant Engineering Conference, Royal Orleans Hotel, New Orleans, La.

June 4–8, 1962

Nuclear Congress (Biennial), New York Coliseum, New York, N. Y.

June 5–7, 1962

ASME Fuels Symposium, Rutgers University, New Brunswick, N. J.

June 10–14, 1962

ASME Summer Annual Meeting, Chateau Frontenac, Quebec, Canada

(*For Meetings of Other Societies, see page 93.*)

Note: Persons wishing to prepare a paper for presentation at ASME National meetings or Division conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Price to nonmembers, 50 cents; to ASME members, free. Also available on request is a "Schedule of Program Planning Dates for Meetings and Publication Deadline Dates." Ask for Form M&P 1315.

Nucleonics Heat-Transfer Conference

A CONFERENCE is to be held April 26–27, 1962, at Argonne National Laboratory, Chicago, Ill., under sponsorship of the ASME Nucleonics Heat-Transfer Committee. Plans are being formulated for a two-day meeting with four sessions, tentatively identified under the following headings:

Session 1, Heat Transfer in Water Reactors;

Session 2, Heat Transfer in Other Reactors;

Session 3, Computer Codes, Test Apparatus Design, and Instrumentation in Reactor Heat Transfer; and

Session 4, Actual Heat-Transfer Performance in Reactors.

Papers suitable for presentation in this conference are to be submitted by Aug. 1, 1961, to the papers chairman, Dr. Joseph D. Roarty, Bettis Atomic Power Laboratory, P. O. Box 1468, Pittsburgh 30, Pa.

Conducted for the National Junior Committee

J.W. FOLLANSBEE[1]

JUNIOR FORUM

Three Good Questions

A FEW days ago an ASME member sent in a letter in which he asked three short questions: "(1) What is the Junior Forum? (2) Who are you? and (3) What is the National Junior Committee?" These questions are stated simply yet they hit right at the meaning of the ASME young members Society activities. They require answers and now. Here they are.

Junior Forum. The space used for these comments is labeled "Junior Forum," and is used by the National Junior Committee to present the Society activities and viewpoints of younger members to the over-all ASME membership. Discussions on various types of engineering jobs (with emphasis on the early phases of a career), commentary on unions, community interests, salaries, ASME committees and activities, and ECPD functions are typical of subjects that have appeared in this space and are indicitive of subjects that will appear in coming months and years.

Between one third and one half of the articles appearing here are submitted by younger ASME members at random; the balance have been written by either members of NJC or the editor of Junior Forum.

Getting articles for this space is tough for several reasons. First, getting company OK's. Second, a good chunck of young ASME members just don't like to submit pertinent comments they feel are written poorly. Third, lack of time. Fourth, lack of interest.

The first two blocks are easily overcome if I and the committee can just get the message across. Articles have been published with no company affiliation following the author's name. And if the issue is really hot, we can publish the article anonymously, but we also reserve the right to know who the author is.

As for the second objection, that's one of the main reasons why there is an editor of Junior Forum. He is not only responsible for writing some material, he also must see to it that all other articles are presented for publication in a reasonable style and with fairly decent grammar; in other words, readable. The third reason is everyone's problem, including mine. You create the time, somehow. The solution to this one is up to the individual.

Last, lack of interest to a great extent means, usually, that the message isn't getting through. We want your comments on jobs and other things engineering, in the form of articles. Three to five pages—typewritten, double-spaced—are enough. Longer pieces also are welcome, but are more subject to cutting back to fit space requirements.

Who Am I? Now, quickly, who am I? I'm a young mechanical engineer (BME '58) who joined ASME while in college and carried on the membership after graduation. I worked on the school engineering magazine a few semesters and, after being mildly active in the New York area for a while, discovered that I had been selected to be editor of Junior Forum for a year. Thus I had some editing experience before taking this job. Being editor is an elective position, lasts about a year, is voluntary, gratis, and an exciting (for me) outside interest. My bread and butter comes from working as an air-conditioning systems designer.

Editors for the space are usually, but not always, drawn from the National Junior Committee membership. The year or so limitation is good for both the column and the editor. It means the reader gets new concepts, styles, approaches, and it frees the editor to go on to other activities. So I am an editor for the National Junior Committee. As of August, Stewart Ross, author of a couple of articles in recent months, and a member of NJC, will be me—namely, the new editor.

National Junior Committee. Finally, what is the National Junior Committee? NJC is a group of young engineers, scattered about the country, whose aim is

[1] Designer, Voorhees, Walker, Smith, Smith & Haines, New York, N. Y. Assoc. Mem. ASME.

to develop programs for ASME that will stimulate the professional development of ASME Associate Members who are younger than 30 years. These programs include nontechnical as well as technical participation in various activities. And the activities usually include a combination of local and national functions.

The Committee has existed since 1947, is small but growing, has its accomplishments, plans, and problems. Norman Viehmann is the present Chairman of the group, which numbers ten or so, and if you're interested in more details, write to him at Dept. 115, Western Electric Company, North Andover, Mass. Also check the Junior Forum column of April for names and addresses of members who are active with the group in the various ASME Regions.

I could go on at length, but this has the essense of the matter. It is difficult to put in so many words "What is the National Junior Committee?" The group's work isn't spectacular nor headline grabbing, but it's good, solid work and they've done a lot since their feeble beginning. It seems to me an exciting bit, since it's strictly for young men and it's a group where you can sound off about your thoughts and concepts, about engineering and ASME and its relation to you and your community, and you'll know that your listeners will listen, even if they don't agree.

One last note. This concerns my mention of speed reading. I've received requests for more information about the subject. The data gathering is a slow process for several reasons but I should have something, for those interested, in the August issue.

ACTIONS ASME EXECUTIVE COMMITTEE

A MEETING of the Executive Committee of the Council was held on Friday, May 12, 1961, in the rooms of the Society.

There were present: W. H. Byrne, President; D. E. Marlowe, H. N. Muller, and L. N. Rowley of the Executive Committee; E. J. Kates, Treasurer; E. J. Schwanhausser, Finance Committee Chairman; A. C. Pasini, Finance Committee; H. R. Kessler, Organization Committee; H. J. Heneman, R. M. Wilson, and D. R. Earich of Cresap, McCormick and Paget; O. B. Schier, II, Secretary; W. H. Larkin, W. E. Letroadec, W. E. Reaser, S. A. Tucker, and J. D. Wilding, Assistant Secretaries; H. I. Nagorsky, Controller; J. J. Jaklitsch, Jr., Editor; D. B. MacDougall, Associate Head, Field Service; J. T. Reid, Research Manager; and L. S. Dennegar, Public Relations Director.

Board on Honors. The Board on Honors, at its meeting on May 9, 1961, approved the recommendations of the Medals Committee that the following honors be given for 1961:

ASME George Westinghouse Gold Medal to Gerald Vincent Williamson, Fellow ASME;

Holley Medal to Thomas Elmer Moon of Philadelphia, Pa.;

Spirit of St. Louis Medal to Samuel K. Hoffman, vice-president, North American Aviation, Inc., and president, Rocketdyne;

Timoshenko Medal to James Norman Goodier, Mem. ASME;

Machine Design Award to Robert Gilmore LeTourneau, Fellow ASME. (Presented at Design Engineering Conference in Detroit, Mich., May 24, 1961. See pp. 98–99 of this magazine.)

Worcester Reed Warner Medal to C. L. Willibald Trinks, Fellow ASME;

Melville Medal to Otto Erich Baljé, Mem. ASME;

Prime Movers Committee Award to Charles Strohmeyer, Jr., Mem. ASME;

Blackall Machine Tool and Gage Award to Joseph Rudolph Roubik, Assoc. Mem. ASME;

Junior Award to Joseph Edward Fleckenstein, Assoc. Mem. ASME;

Arthur L. Williston Medal and Award to James Robert Stewart, Student Mem. ASME;

Pi Tau Sigma Richards Memorial Award to Harrison Allen Storms, Jr., president, Space and Information Division, North American Aviation, Inc.; and

Pi Tau Sigma Gold Medal Award to Ernest Theodore Selig, Assoc. Mem. ASME.

Charles T. Main Topic. On recommendation of the Board on Honors, the Executive Committee of the Council accepted "Moral Standards—Values to an Engineer," as the topic for the 1962 Charles T. Main Award.

Boiler and Pressure Vessel Committee. *Welding Research Council.* The Executive Committee of the Council, on recommendation of the Boiler and Pressure Vessel Committee, authorized the payment of $1000 to the Welding Research Council of the Engineering Foundation, from the "A" Development Fund, as the 1961 contribution of the Society to the work of the Pressure Vessel Research Committee.

Sections. *Evansville Group of the Paducah Section.* The Executive Committee of the Council authorized the formation of the Evansville Group of the Paducah Section with headquarters at Evansville, Ind., and the territory to include the following counties: Indiana—Knox, Daviess, Martin, Gibson, Pike, Posey, Warrick, Spencer, and Vanderburgh; Illinois—Wabash, Edwards, White, Gallatin, Hamilton, Saline, and Hardin; Kentucky—Union, Henderson, Daviess, Webster, McLean, Hopkins, Muhlenberg, Todd, and Christian.

Connecticut Valley Group of the Northern New England Section. The Executive Committee of the Council authorized the formation of the Connecticut Valley Group of the Northern New England Section with headquarters at Bellow Falls, Vt., and the territory to include the following counties: Vermont—Bennington, Windham, and Windsor; New Hampshire—Cheshire, Sullivan, and Grafton.

Affiliations of the Five Connecticut ASME Sections. In accordance with Council action, the Resolutions adopted by the Connecticut Technical Council were submitted for study to the Society's legal counsel. On recommendation of legal counsel, the Executive Committee of the Council voted to deny authorization for the five ASME Connecticut Sections to affiliate with the Connecticut Technical Council.

ASME Organization Study. At the request of the Executive Committee of the Council, Messrs. H. J. Heneman, R. M. Wilson, and D. R. Earich of Cresap, McCormick and Paget spent an hour answering numerous questions regarding the conduct of the study, their findings, and their proposals. Their answers served to clarify several major points and will facilitate an evaluation and possible implementation of the 18 proposals contained in the study.

ASME Emblem. The Executive Committee of the Council authorized the use of the ASME emblem on a certificate to be presented by the New Mexico Section to the winner of the Student Paper Award.

Engineers' Council for Professional Development. *Revised Charter and Rules of*

Procedure. At its meeting on March 16, 1961, the Executive Committee of ECPD declared the revised Charter and Rules of Procedure, having been approved by the required number of participating societies, to be in effect.

Admission of Additional Participating Societies. Upon approval of the required number of participating societies, the Executive Committee of ECPD voted to extend an invitation to the Institute of Radio Engineers and the Institute of the Aerospace Sciences as participating societies of ECPD.

The American Society for Engineering Education. ***Resolution to the National Science Foundation.*** The Executive Committee of the Council voted: *(a)* To endorse the Resolution relative to the establishment by the National Science Foundation of a separate "division of engineering science" prepared by ASEE; and *(b)* to advise the NSF of this action.

Certificates of Award. ***1961 Agenda Committee.*** A certificate of award has been prepared for J. David Carr, who served as the chairman of the 1961 Agenda Committee.

1961 RDC Senior Delegates. Certificates of award have been prepared for the following members of the 1961 RDC Senior Delegates: Richard Neuendorffer; Edward Miller; Thomas Howitt, Jr.; G. B. DeHoff; C. E. Evanson; B. G. Barr; W. H. Kohler; and C. E. Redfern.

1961 Nominating Committee. Certificates of award have been prepared for the following members of the 1961 Nominating Committee: W. F. Belcher, Jr., Chairman; J. R. Muenger, Secretary; Z. R. Bliss; D. B. Chenoweth; R. G. Critz; N. J. Hoff; R. L. Hollaway, Jr.; E. W. Jerger; J. W. MacPherson; F. K. Mitchell; C. G. Parker; R. B. Stewart; and Erskine Vandergrift, Jr.

Codes and Standards. Upon approval of the Board on Codes and Standards, certificates of award have been prepared for the following for their outstanding leadership in the development of Codes and Standards sponsored by the Society: M. A. Princi, ASA Sectional Committee C85; O. W. Boston, H. E. Harris, Christian Borneman, A. F. Murray, and G. F. Habach, ASA Sectional Committee B5; and Z. R. Bliss and F. H. Colvin, ASA Sectional Committee B4.

Retired Section Member Gifts Campaign Chairman. On recommendation of Vice-President Muller, Region V, the Executive Committee of the Council authorized the preparation of a certificate of award for Warner Seeley, past-chairman of the Cleveland Section Member Gifts Campaign for his efforts in attaining 100 per cent of quota for the Section.

Retired Section Chairmen. On recommendation of their respective Vice-Presidents certificates of award have been prepared for the following 1959–1960 retired Section chairmen: A. D. Roubloff, Buffalo; Robert Juer, Central Virginia; R. C. Austin, Detroit; T. A. Weyher, Miami; P. W. Kelly, Rock River Valley; M. J. Spruitenburg, Susquehanna; M. B. Thacker, Utah; and Donald Taylor, Worcester.

Retiring Section Chairmen. Upon recommendation of their respective Vice-Chairman, certificates of award have been prepared for the following retiring Section chairmen (1960–1961): A. J. Westbrook, Buffalo; E. C. Taylor, Central Virginia; and C. S. Howland, Jr., Northeast Florida.

Appointments. ***Presidential.*** D. E. Marlowe, IAS Banquet honoring Dr. Theodore von Karman on his 80th birthday, May 11, 1961, Washington, D. C.

E. W. Burstadt, AIIE Annual Banquet, May 11, 1961, Detroit, Mich.

ASME CODES AND STANDARDS WORKSHOP

Interpretations of 1955 Code for Pressure Piping

From time to time certain actions of the Sectional Committee B31 will be published for the information of interested parties. While these do not constitute formal revision of the Code, they may be utilized in specifications, or otherwise, as representing the considered opinions of the Committee.

Pending revision of the Code for Pressure Piping, ASA B31.1—1955, the Sectional Committee has recommended that ASME, as sponsor, publish selected interpretations so that industry may take immediate advantage of corresponding proposed revisions. Case No. N-2 is published herewith as an interim action of Sectional Committee B31 on the Code for Pressure Piping that will not constitute a part of the Code until formal action has been taken by the ASME and by the American Standards Association on a revision of the Code.

Case N-2, Requirements for Valves in Nuclear Piping Systems

Inquiry: What are the requirements for valves used under the rules of ASA B31.1 in nuclear piping systems?

Reply: It is the opinion of the committee that valves used in nuclear piping systems must meet the following requirements:

(1) Be of materials recognized by ASA B31.1, Section 1-1955 and code cases prefixed by 'N' as satisfactory for the specified service. They shall, wherever possible, conform to a recognized standard, such as ASA B16.5.

(2) Valves must at least meet the physical and inspection requirements of Case N-10 for cast austenitic materials.

(3) Have some sort of positive sealing (such as capped, bellows, welded, diaphragm, double packing with lantern gland) or some other provision for stem and bonnet leakoff control which reasonably insures that leakoff can be contained within the main or auxiliary nuclear piping systems. This restriction does not apply to valves two inches and smaller when used in water and steam service provided that valves are of backseating type.

(4) Screwed end valves in which threads provide the only seal are not permitted in nuclear piping systems.

Instruments and Apparatus Supplement on Temperature Measurement

By W. A. Hadley[1]
Chairman of PTC Committee No. 19/B

Temperature Measurement, the latest Power Test Codes Supplement on Instruments and Apparatus, has just been published by the ASME. This Supplement is Part 3 of the series and replaces an older one published separately in eight chapters during the period 1931 to 1945. Since that time the technology of temperature measurement has so changed and broadened that the earlier material

[1] Technical assistant to vice-president, Research & Development Division, American Machine & Foundry Company, New York, N. Y.

has become obsolete. This necessitated a complete revision of the Supplement resulting in the currently expanded and more comprehensive document.

This new Supplement has 118 pages which makes it the largest supplement published by the Society with Flow Measurement a second. The material has been expanded to nine chapters and includes one chapter on Bimetallic Thermometers and another on Calibration of Instruments. The other chapters on Radiation Thermometers, Thermocouple Thermometers, Resistance Thermometers, Liquid-in-Glass Thermometers, Filled System Thermometers, and Optical Pyrometers have been rewritten completely and brought up to date.

The Supplement not only deals with the various temperature measuring instruments but also presents in the first chapter a summary discussion of temperature measurement as related to Power Test Code Work with particular emphasis on basic sources of error and means for coping with them.

Measurement of temperature is generally considered to be one of the simplest and most accurate measurements performed in engineering. This is decidedly a misconception. Accurate temperature measurement under some conditions is impossible with our present knowledge. Under many of the conditions met in Power Test Code Work, the desired accuracy in the measurements of temperature can be obtained only by observance of suitable precautions in the selection, installation, and use of temperature measuring instruments; and in the proper interpretation of the results obtained with them. In some cases an arbitrarily standardized method is prescribed in the Power Test Codes which is to be followed in making temperature measurements under such conditions.

Some of the instruments available for temperature measurement are capable of indicating temperature to a closer degree of accuracy than is required in some of the tests considered in the Power Test Codes. The difficulty in obtaining accurate temperature measurements with such instruments is encountered in installation or use of the temperature measuring instruments. Specific directions and precautions in usage of the instruments are given in subsequent chapters for each of the various types of temperature measuring instruments.

The work on the Supplements on Instruments and Apparatus was initiated by the ASME in December, 1918, and from that time until November, 1950, the work on all of the various supplements was done by one committee, PTC Committee No. 19 on Instruments and Apparatus. In November, 1950, the work was broken down into technical committees by subject matter and PTC Committee No. 19/B came into being to handle the work on Temperature Measurement. The men who actually produced this new Supplement were assembled in February, 1956, when the technical committees were reorganized by Rawleigh M. Johnson, the Chairman of the standing Power Test Codes Committee.

From 1957 to 1959 the Chairman of PTC Committee No. 19/B was required to be in Europe by his employer and during this period the Vice-Chairman, James W. Murdock, took over the direction of the work. The final writing was done under his direction as the Chairman returned only in time to assist with the final typescript and the page proofs. The committee consisted of the following: W. A. Hadley, Chairman, American Machine & Foundry Company; J. W. Murdock, Vice-Chairman, U. S. Naval Boiler & Turbine Laboratory; R. C. Stroud, Secretary, Leeds & Northrup Company; G. J. Black, Westinghouse Electric Corporation; A. I. Dahl, General Electric Company; K. P. Hanson, North Carolina State College; C. A. Macaluso, Worthington Corporation; R. D. Thompson, Taylor Instrument Companies; C. A. Vogelsang, Brown Instruments Division of Minneapolis-Honeywell Regulator Company; and A. A. Zuehlke, Bourns Incorporated (formerly Taylor Instrument Companies).

Pamphlet copies of the Supplement (PTC 19.3-1961) are available from the Society's Order Department for $5.50 a copy.

Instruments and Apparatus
Measurement of Rotary Speed

By Howard S. Bean[2]
Chairman of PTC Committee No. 19/C

PTC Committee No. 19/C on Instruments and Apparatus has completed the revision of the Supplement on Instruments and Apparatus, Part 13 on Measurement of Rotary Speed (19.13-1960).

This Supplement on Speed Measurements, or more precisely, Rotational Speed Measurements, was originally issued in 1930 and reissued with minor revisions in 1939. By the time this last issue was exhausted, it was outmoded, due in part to the ever increasing speeds of various machines and power units, and in part to the development of apparatus for detecting and indicating these high speeds.

About 1954 it was learned that the American Institute of Electrical Engineers had appointed a committee to prepare material on rotary speed measurements. Since there is a considerable area of common interest between the two societies in machine speeds, it seemed desirable to establish a close working liaison between the AIEE writing group and PTC Committee No. 19 on Instruments and Apparatus. Accordingly, a member of the AIEE writing group, R. L. Sanford, was invited to be a member of the task force to prepare the revision of I & A, Part 13. Due to this arrangement much of the material in the revised supplement is identical with that of the current AIEE Guide on Rotary Speed Measurements.

The instruments and procedures described in this supplement apply only to steady-state conditions, that is to the measurement of speeds that are constant for a finite length of time. This finite length of time may be only one second, but usually it will be very much longer. A reason for this limitation is that the fundamental principles involved in the measurement of variable speeds; i.e., acceleration, are quite different from those underlying the measurement of steady speeds. Also, for most all acceptance tests steady-state conditions are a prerequisite.

Measurements of rotary speed are made for a variety of purposes on machines having widely differing characteristics. Usually, there are several different instruments or methods which would serve equally well for a particular case. It is properly within the province of the testing engineer in charge to specify which instrument or method is to be used in any test which requires the measurement of rotary speed.

The primary purpose of Part 13 is to describe the instruments and methods commonly used for the measurement of rotary speed or slip and to give information regarding the characteristics and limitations of commercially available instruments ordinarily employed in connection with the testing of any rotating machinery, turbine, blower or electric motor.

Inasmuch as most codes for testing rotating machinery relate only to steady-state conditions, the direct measurement of transient variations of speed or acceleration or deceleration are not covered in this supplement.

The members of the task force responsible for the preparation of Part 13 are: N. R. Deming, Westinghouse Electric Corporation; R. L. Sanford, National Bureau of Standards; and S. H. J. Womack, National Bureau of Standards.

Pamphlet copies of the Supplement (PTC 19.13-1960) are available from the

[2] Consultant on fluid metering, liquids—gases, Kensington, Md.

Society's Order Department for $2 a copy.

Instruments and Apparatus Supplement on Measurement of Shaft Horsepower

By W. G. McLean[3]
Chairman of PTC Committee No. 19/E

Some four or more years ago Rawleigh M. Johnson, Chairman of the Power Test Codes Committee, indicated the need for the publication of an Instruments and Apparatus Supplement on the Measurement of Shaft Horsepower of Rotating Machines by Direct and Indirect Methods. A technical committee under the auspices of the Power Test Codes Committee was formed to delineate the problem. The members are: D. H. Burton, Clark Brothers Company, Inc.; A. A. Emmerling, General Electric Company; D. R. Jenkins, Lafayette College (formerly General Motors Institute); A. K. Joecks, Consolidated Edison Company of New York, Inc.; E. J. Jones, Bytrex Corporation (formerly Baldwin-Lima-Hamilton Corporation); W. G. McLean, Lafayette College; and Daniel Nobles, Worthington Corporation. Many meetings were held, and as usual with committees, the work of one meeting would be discarded at the next meeting only to be reinstated at the third meeting.

A serious attempt was made to collect the various means of measuring horsepower as they are used in test code work for turbines, pumps, blowers, fans, reciprocating compressors, etc., and to describe each together with its limitations with regard to speed and torque. This was not easy because there was no previous publication on which to build. After two years the committee distributed a document among interested members of the Society and the Power Test Codes Committee for comments. These comments were included in a final draft of the Supplement, which after being set in type, was again sent to the members of the standing Power Test Codes Committee for approval.

This approval has now been given and after minor revisions the final document has been published. When you consider that the committee consists of volunteers, it is not strange that this process takes so long. However, a paid committee could not be as loyal. It is in volunteer activity such as this that our members contribute greatly to our profession.

Pamphlet copies of the Supplement (PTC 19.7-1961) are available from the Society's Order Department for $2.50 a copy.

[3] Head, Department of Mechanics, Lafayette College, Easton, Pa.

1961 Report of Joint Committee on Uniformity of Methods of Water Examination

The Joint Committee on Uniformity of Methods of Water Examination (JCUMWE) completed its fifth year of operation as of March 1, 1961. The Committee is made up of representatives of 12 technical organizations, of which ASME is one, engaged in the development and publication of methods of water examination. The objectives of JCUMWE are to review methods of examination published by member organizations to obtain uniformity in sampling, testing, reporting test data, and terminology; and to provide for exchange of information.

The review of methods of examination is accomplished by panels composed of outstanding specialists. When a panel report is approved it becomes a Preliminary Recommendation which is then referred to member organizations. After review and study by member organizations the Preliminary Recommendation, including approved revisions, is issued by JCUMWE as an Official Recommendation.

Official Recommendations. Official Recommendations have been approved by JCUMWE for reporting of results, total hardness, iron, organic nitrogen, grease and oil matter, solids, and manganese (approved but not yet released).

Preliminary Recommendations. Preliminary Recommendations, including those approved during the past year, are under review by member organizations for sulfate, uniformity of reagents, acidity, and alkalinity.

Thirteen panels were active during the past year covering methods of examination for ammonia; calcium and magnesium; carbonate, bicarbonate, and carbon dioxide; chemical oxygen demand; chloride; dissolved oxygen; electrical conductivity; fluoride; lead; odor; pH-glass electrode; total phosphorus; and turbidity.

Four panels were previously authorized but not activated as of March, 1961, for chlorine residual, chromium, nitrite, and silica. New panels were authorized for nitrate and biochemical oxygen demand.

Work was completed on revision of JCUMWE Regulations which will be distributed to member organizations.

The following organizations are members of JCUMWE: AOAC, ASTM, AWWA, API, APHA, ASME, MCA, TAPPI, USGS, USP, USPHS, and WPCF. Joseph W. Strub, senior service engineer, Engineering Service Division, Engineering Department, E. I. du Pont de Nemours & Company, Inc., is ASME Representative.

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC [Agency]

These items are listings of the Engineering Societies Personnel Service, Inc. This Service, which co-operates with the national societies of Civil, Electrical, Mechanical, and Mining, Metallurgical and Petroleum Engineers, is available to all engineers, members or nonmembers, and is run on a nonprofit basis.

If you are interested in any of these listings, and are not registered, you may apply by letter or résumé and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee. Upon receipt of your application a copy of our placement-fee agreement, which you agree to sign and return immediately, will be mailed to you by our office. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application.

NEW YORK	CHICAGO	SAN FRANCISCO
8 West 40 St.	29 East Madison St.	57 Post St.

Men Available[1]

Chicago Office

Project Engineer, BSME, 15 hours' graduate work; 29; two years' experience in design, test and ballistic kinematic, and stress analysis of propellant actuated devices; 1½ years test of optical equipment used for artillery-fire control; one year plant engineering. Open. Immaterial. Me-2204-Chicago.

[1] All men listed hold some form of ASME membership.

Supervising Test Engineer (Mechanical), BSME; 35; three years' experience development testing liquid rocket components, hardware; now in charge of lab; six years applied research, machines, and devices; 12 years' total experience. Desires stable company and community. $12,230. Midwest-West. Me-2205-Chicago.

Mechanical Engineer, four years' college, Univ. of Cincinnati, I.I.T.; registered PE; experience in automatic machine design, hydraulic press, machine-tool design, hydraulic pump, and valve design. Chief engineer, project en-

gineer, cousulting engineer. $10,000 Prefers vicinity of Chicago, Ill. Me-2206-Chicago.

Mechanical Engineer, design or development, Dipl. Eng.; 28; seven months' experience in machine factory, design of parts, auxiliaries for diesel engines; three years at steel-construction company, design of structural and mechanical parts, equipments for buildings, plants, mines; welding specifications; estimating. $5000, minimum. Any except South. Me-2207-Chicago.

Design or Project Engineer, BS, Mechanical Engineering; 37; 14 years diversification in engineering design, layout, and board work. Designer in R&D for product diversification. Some experience in hydraulic and pneumatic circuitry. Knowledge of mining equipment. Shop foreman. $10,000-$12,000. Prefers Chicago area. Me-2208-Chicago.

Manager Manufacturing, equivalent to BSME; 37; more than 20 years' experience associated with aero engine and machine-tool industries; background in cost control, estimating, process planning, tool design, quality control, personnel supervision, sales contact, and bid presentation. $13,000 Immaterial. Me-2209-Chicago.

Chief Engineer, BME; 43; 12 years' experience as engineering executive in heavy machinery-manufacturing business. $15,000, minimum. Immaterial. Me-2210-Chicago.

Mechanical Engineer, BSME; 33; ten years' experience in design and major replacement work on mechanical equipment for large steam-power plants, includes specifying and selecting major equipment, designing piping systems, and checking detail drawings for compliance with design. $10,000. North. Me-2211-Chicago.

New York Office

Heat-Pump Design Engineer, MS(ME); eight years' experience in the design, control circuitry, prototype fabrication, and test of air and water-source heat pumps as well as auxiliary strip heat. Registered PE in Ohio and Florida. $10,000. Location immaterial. Me-957.

Power-Plant Engineer or Administrative Assistant to Chief Engineer; 45; Naval officer, retiring Commander in June 1961, 20 years; assistant chief engineer, chain-manufacturing plant, four years; supervising inspector for insurance company, six years. Prefers Maine to Fla., eastern U. S. Me-958.

Engineer, BS(ME), candidate for MS in Eng. Admin.; 52; ten years' experience in mechanical design, consulting work, locks, dams, structural, water supply, and steam plants; 20 years' experience in field operations, construction, studies, and technical management. Prefers Fla., East, or South. Me-959.

Manufacturing Manager, BBA, Engineering and Management; 41; plant manager six years in metalworking industry. Chief industrial engineer for seven years. Experienced in union negotiations, product development, incentives, job evaluation, and scheduling. New England or West Coast. Me-960.

Chief Engineer, Plant Manager, Technical Director, MSME; 38; eight years' experience process and equipment development, pilot-plant design, and operation in the food industry. Thermal, hydraulic, and mechanical design of nuclear reactors. Design and construction of nuclear-testing facilities. Desires more responsibility. $18,000. Prefers 200-mile radius of N. Y. C. Me-961.

Senior Production Engineer, BS, mechanical engineering, AB industrial engineering; 15 years' experience in the design, development, and producibility of wide variety of complex electromechanical equipment. Also, considerable managerial and staff experience, with unusual background of industrial engineering disciplines. $12,000 Immaterial. Me-962.

Steam-Power Engineer, BS(ME); 23 years' experience in management of design, construction, and operation of steam-power projects. Licensed for operation and design. $15,000. N. Y. C. or N. J. Me-963.

Junior Mechanical Engineer, BS(ME); 12 credit hours toward MS in nuclear engineering; 2 semesters of nuclear engineering technology lab dealing with heat-transfer analysis of core, operation of subcriticals, etc. Noncitizen applying for citizenship. $540 a month. Prefers within 40 to 50 miles of N. Y. C. Me-964.

Plant Engineering or Production Management, BSME, IE option; 29; four years' experience industrial engineering; two years' experience project engineering, same company, process industry. Open. Northeast. Me-965.

Assistant Sales Manager, ME; five years' experience as sales engineer calling on utilities and consulting engineers; large following; reputation impeccable. $10,500. New York Metropolitan area. Me-966.

Manufacturing Engineer, MS Industrial Engineering, BS Metallurgical Engineering; registered PE Michigan and Pa.; varied automotive manufacturing experience, five years; carbide tooling, five years; atomic power-plant manufacturing, 2 years; plastic molding, a year plus. Knows statistical quality control, processing, plant engineering. Good investigator, analyzer, planner for correction of manufacturing problems. Immaterial. Me-967.

Director of Engineering, MME; 38; 16 years' experience in development of vending machines, coin mechanisms, consumer products, business machines, air-conditioners, and teletype equipment; also military equipment. Eastern U. S. Me-968.

San Francisco Office

Sales Manager, Industrial, ME; 45; 15 years' experience in manufacturing, quality control, design, research, development, sales in machine tools, gages, business machines, automotive engine parts, agricultural machinery. $14,000. Any location. Se-241.

Plant, Product Engineer, Metalworking, ME; 38; solid academic training plus ten years' mechanical-equipment design experience and supervision. Positions held at all levels of plant and product design, layout, development and supervision of metal-shop production. $600. Prefers San Francisco Bay area. Se-134.

Instructor, | Research - electromechanical, MSME; 31; two years' design in aircraft navigational instruments; one year assistant in acoustical study of refrigeration compressors working with sound measurement. Studies of thermodynamic cycles, heat transfer, compressors; one year teaching engineering problems; two years operating and maintenance hydrogen and nitrogen production facilities. $7500. Prefers East, West U. S., or Foreign. Se-182.

Sales Supervision-Construction, ME; 43; mechanical and electrical construction experience on buildings. Also experience in civil engineering of heavy construction and housing subdivisions. Acquainted with many contractors in northern and central Calif. $650 a month. Prefers San Francisco Bay area, northern Calif., Nev. Se-142.

Specifications and Reports Writer; 54; mechanical background; six years specifications and reports, general construction, military installations and hydroelectric, irrigation projects; one year reports, proposals, electronic R&D; 3 years writing O&M manuals. Formerly architectural engineer; Captain, Corps of Engineers; certificate as associate specifications writer. $650-$850 a month. Prefers San Francisco Bay area. Se-686.

Project, Senior Engineer, Food, Chemical; ME; 47; ten years supervision of development, design, and manufacture of automatic processing machinery, direction of process and plant engineering, construction installation, operations, and maintenance. Also, experience in machine design, chemical engineering, process design, and development engineering. $15,000, to start. Prefers southern Calif. Se-306.

Production, Plant Manager, electromechanical, metalworking; industrial engineering; 39; 11 years' experience in all phases of production management including production supervision, production control, methods engineering, plant engineering, and plant layout. $12,000-15,000. Prefers San Francisco area. Se-303.

Designer, Draftsman, missiles, aircraft, ME; 26; designed pneumatic machinery and control circuits. Computed mathematically and analytically all computations, made drawings and modify. $600 a month. Prefers San Francisco Bay area. Se-186.

Program Representative, Physicist, aerospace, electromechanical, mathematics background; 35; experienced in all phases of engineering, R&D relating to sophisticated controls, fuel, ballistics, structural including research editing, computer usage, and design. Desires aerospace assignment in management group or as company representative. $10,000, and up. Prefers New York, Europe, Calif. Se-148.

Project, Design, Planning Engineer, nuclear industrial plants, ME; 47; over two years experience as project engineer doing analysis, hazards studies, operation, costs studies, development work on nuclear reactors; over a year designing components, making feasibility studies in connection with nuclear equipment. $10,500. Prefers San Francisco area but will consider any. Se-227.

Sales Engineer, process-plant equipment; 56; experience in merchandising and selling process equipment, laboratory equipment, pressure vessels, heat exchangers, motors, pumps, refrigeration. $600 a month up. Prefers Pacific Coast. Se-195.

Chief Designer, aerospace, special machinery, ME; 35; 15 years' experience in advanced work on mechanisms and structural involving stress, mechanisms, control, and power fields. $12,000-$15,000. Prefers West or Midwest U. S. Se-1647.

Production Engineer, light or heavy manufacturing, ME; 47; diversified experience in heavy and light industry, also purchasing and sales. $750 a month. Prefers West Coast or Foreign. Se-1552.

Design, Research, Development Engineer, metalworking, ME; 40; 14 years' experience in research, development, and design of internal-combustion engines (structure development to withstand shock vibrations, design studies of various engines); six years' machine-shop experience building tool and die fixtures. $12,200. Prefers Western U. S. Se-1587.

Sales Engineer, machine tools, heavy machinery, ME; 47; nine years' sales experience in machine tools, bearings, gears, electric motors, air conditioning, furnaces, water heaters, tools and dies, and diesel engines. $600 a month. Prefers northern Calif. Se-1539.

Sales Engineer, consumer products, ME; 39; nine years' sales experience in water-heater equipment, installation, selection, service in central and northern Calif. Experience in staff-level administration. $9000-$10,000. Prefers San Francisco East Bay. Se-1824.

Positions Available

Chicago Office

Project Engineer, graduate mechanical, at least four years' experience, preferably in transmissions or gearing. At project level will be responsible for assignments including all work necessary to planning and carrying out programs. Supporting personnel of various kinds is available from the initial design and analysis through fabrication, test, and development procedures for a manufacturer of engines and clutches. About $10,800. Mich. C-8703.

Project Engineer, graduate mechanical, about 45, to supervise and be responsible for mechanical power-plant section of prominent consultant. Most of work will be on steam-power plant and piping. Occasional field trips necessary. About $12,000. Employer pays fee. Chicago, Ill. C-8675.

Machine Designer, BSME, some work on MS desired, to 35, at least two years' experience in design of high-speed automatic machinery. Must have been in upper 20 per cent of class; for a manufacturer of can-making machinery. About $7800. Employer pays fee. Southern Wis. C-8672.

Project Design and Development Engineer, graduate, for hydraulic and mechanical design and development of self-priming and/or straight centrifugal pumps. Company employs about 100 and has a national distribution in the domestic farm and industrial pumping fields. Good opportunity. $7000-$9000. Company will negotiate fee. 150 miles in Ill. from Chicago. C-8659.

Director of Engineering, graduate mechanical or electrical, 45-50, to be responsible for all product development and design of small electromechanical devices, especially small electrical switches. $18,000-$25,000. Employer pays fee. New York, N. Y. C-8657.

New York Office

Market Research Analyst, five years' experience in market research to do market research and evaluation of new products developed in the R&D labs. Familiar with operations of a large corporation and with a flexible approach to market strategy. Company pays fee. East. W-548.

Engineers for Mechanical-Development Lab. (*a*) Senior designer to act as lead designer for design of automatic machinery and devices; to make over-all machine layouts and direct work of other designers and draftsmen. Ten to 15 years' experience in design of automatic machinery. Experience in mechanisms or electromechanisms helpful. (*b*) Mechanical engineer,

graduate, to develop and carry out engineering programs in order to adapt product design for economical manufacture; five to ten years' varied experience in electromechanical design, production, manufacturing, or industrial engineering. Experienced in liaison with outside contractors involving procurement, design, cost estimating, or manufacturing studies. (c) Senior designer for the design of plastic parts for consumer products. Design experience on molds for plastic parts desirable. Capable of designing for function, manufacturability, and cost. Initial assignment on thermodynamic equipment installation. Company pays fees. East. W-456.

Consulting Engineer, experience in gas or oil pipeline work and a thorough knowledge of the equipment used. Some experience in purchasing such equipment for an international company. Open. Canada. F-448.

Chief Project Engineer, graduate mechanical, 15 years' experience, for the project management of all engineering programs including overall planning, budgeting, scheduling and assigning of personnel, through design, development, and customer contact to completion on space and rocket engineering and components manufacture. To $18,000. New York, N.Y. W-442.

Superintendent, Plant Operation, Buildings, and Grounds, for a large medical center, 35–50, graduate mechanical or electrical, five to ten years' experience in maintenance work. Will administer and direct program involving maintenance of buildings and grounds, equipment and distribution lines for steam, hot water, plumbing, electricity, refrigeration, and sanitation; compute costs, schedules, and expedite operations and repairs; supervise emergency and major repair jobs; and periodically inspect equipment and buildings; prepare engineering maintenance budget estimates. $9000–$12,000. N. J. W-432.

Development Engineers. (a) Senior, to 40, BS(ME), MS preferred, to be utilized in machine and process development. Will originate and design sections of new equipment. Six years' experience required, preferably in the synthetic fiber industry; will consider experience in the plastics industry. To $15,000. (b) Semi-Senior, BS(ME), chemistry, physics, or chemical engineering, to 35, to work with the development of new processes in R&D group, two to six years' experience, preferably in synthetic fibers. Some process-engineering experience desirable. To $11,000. (c) Juniors, BS(ME), chemistry, physics, or chemical engineering, to 35, one to six years' experience, preferably in process engineering. Will work in development and evaluation of new processes in R&D group. To $9500. Company pays fees, interviewing, and moving expenses. N. C. W-427.

Sales Manager, graduate, for small company manufacturing chucks. Must know his way around any machine shop and have some previous selling experience. Considerable travel. $10,000. Headquarters, Conn. W-424.

Research Engineers, mechanical-engineering background, with product-engineering department, to explore new materials, construction techniques, new hardware products (builders doors, windows, automatic opening and closing devices), principles of mechanics. Some knowledge of manufacturing. $9000–$12,000. Conn. W-422.

Technical Writer, graduate mechanical, 24-30, minimum of two years' experience. Under direction will be responsible for keeping up-to-date on all technological developments in the ball-bearing industry, including manufacturing techniques, measurement, quality control, and design innovations. Will be accountable for the technical accuracy and creative approach of all articles. Will write articles for placement in trade and technical publications, application data sheets, advertisements, etc. Open. New England. W-419.

Manufacturing Engineers, graduate mechanical, industrial, and electrical, five years' experience in analyzing producibility and solving fabrication and assembly problems of military electronic and electromechanical equipment; familiarity with prototype and production manufacture techniques. Capable of writing test specifications and procedures. Heavy estimating on bid proposals; i.e., electrical and mechanical assembly and some machine and sheet metal. $8000–$10,000. Company pays fee. N. Y. suburban area. W-416.

Supervising Project Engineer, graduate mechanical or electrical, five to ten years' experience on the design, calculations, and packaging from the electronic and mechanical side of hearing aids. $12,000–$15,000. Conn. W-412.

Designers. (a) Pressure vessels, graduate mechanical or chemical, two to fifteen years' experience, with some design and/or fabrication experience with high-temperature, high-pressure carbon and stainless-steel vessels; or experience related to the design of cracking towers in the petroleum industry. To $10,800. (b) Heat exchanger, graduate mechanical, two to ten years' experience, with some design and/or fabrication experience with high-pressure, high-temperature heat exchangers. Working knowledge of commercial and military code requirements relative to this equipment would be applicable. To $10,800. Pa. W-404.

San Francisco Office

Sales Engineer, specialty fabricated steel products, preferably graduate mechanical, 30–45, eight or more years' sales experience, some sales administration. Experience related to instrumentation, controls for boilers, chemical plants, refineries hydraulic control systems. Will sell fabricated steel products (bunks, partition walls, tables, grillwork, electromechanical door actuators, structural and miscellaneous steel, and prestressing for concrete-water tanks). Sell to government agencies, architects, and engineers. Considerable travel, prebid sales promotion, supervise bids, follow-up, etc. $850–$1000 a month plus. Western U. S., Alaska, Hawaii. Sj-5969.

Foundry Superintendent, steel, metallurgical or mechanical graduate, to 55, solid recent and continuous experience in all phases of modern manganese steel foundry operations (electric furnaces, shake out equipment, finishing, complete lab, melting, pouring, casting). For a newly equipped foundry. About $1000 a month. Philippines. Sj-6147.

Field Engineer, process, mechanical, to 55, three to five years' recent experience, to supervise and inspect installation of process piping, pumps, compressors for refinery-type operation. One to two-year job. For an engineering builder. $11,250. Hawaii. Sj-6221.

Assistant Resident Engineer, hydroelectric plant, mechanical, well qualified in field office building hydroelectric plant and installing hydraulic and electrical gear and equipage. Able to deal with engineers, designers, general and subcontractors, and to act for owners in assuring conformance to plans and specifications and processing charges. For an international consulting-engineering firm. $1200 a month. Africa. Sj-6137.

Valuation Engineer, depreciable properties, graduate mechanical or civil; preferably registered; well qualified to appraise and evaluate equipment, properties, facilities resources, to establish proper tax base. Will receive indoctrination in tax law, accounting depreciation. Will act as expert witness representing the federal government. $7500, up. San Francisco. Sj-6138.

Design Engineer, heating, ventilating, air conditioning, mechanical, responsible charge of mechanical design of heating, ventilating, air conditioning for commercial and industrial projects. Must be able to handle complete scope. $8000 up. San Francisco. Sj-6173.

Sales Engineer, hydraulic, to 45, some sales experience, preferably in hydraulic or related, to sell hydraulic pumps and valves in developed territory to missile and heavy industry, manufacturing mobile equipment (not automotive). For a manufacturer's engineering and distribution representative. $600 a month. Northern Calif. Sj-6140.

Design, Development Engineer, automotive bodies, recent graduate mechanical or civil, some structural design experience preferred, for design, development, and board layout on new models or new components for truck trailers. Will handle stress analysis calculations. $500 a month minimum. San Francisco East Bay. Sj-6127.

Sales Engineer, mechanical components, mechanical background, to 40, recent industrial selling experience to users and OEM's, preferably including pneumatic and hydraulic cylinders, hi-pressure pumps, compressors, oil and air filters, lubrication equipment and regulators, tubing fittings. For an established manufacturer's agent with branch offices, dealers, and distributors. Car required. $500–$700 a month base plus. San Francisco. Sj-6160.

Sales Trainee, heating, ventilating controls, graduate mechanical or electrical, young. Evidence of qualifications and aptitude for selling (aptitude tests, previous experience, family background). Will be trained to estimate, bid, assist, and get orders for commercial air conditioning and heat controls from contractors, architects, engineers, owners. Away from home maximum four days a month. For a branch office of a national manufacturer. $500 a month range, car furnished, travel expenses. Cover northern Calif. Headquarters, Sacramento. Sj-6186.

Designer, jigs, fixtures, graduate mechanical or equivalent, to 40, at least two years' experience in design, layout drafting, jigs, and fixtures for power-transmission systems (gears, shafting, housing, bearings, mountings), and accessory equipment. Principally drilling jigs and machining fixtures. For a manufacturer of gear boxes, drives, and power transmission. $600–$650 a month. San Francisco peninsula. Sj-6161.

Assistant Production Engineer, foods manufacturing, graduate mechanical or chemical, either a recent graduate or one to two years' experience, to assist in program involving batch and continuous manufacturing cost reduction and plant improvement. Involves office, plant, and board work with process or production department on layouts and equipment modifications for pressure, packaging, dry process, heat, cool, packaging, handling, some instrumentation. Including effective communications, report writing, cost computations. Later branch into production. For a national foods manufacturer. $500 a month up. San Leandro, Calif. Sj-6229.

Designer, belt conveyer, graduate engineer, preferably mechanical, minimum of four to five years' conveyer-design experience for layout, design, manufacture, and installation of heavy machinery and equipment on wet or dry material handling and processing. For a manufacturer, engineering builder. $650–$750 a month. San Francisco. Sj-6194.

CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

The application of each of the candidates listed below is to be voted on after July 25, 1961, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and Promotions

Alabama

Mitchell, John W., Jr., Birmingham

Arizona

Olsen, Hallett R., Scottsdale
•Peterson, James R., Phoenix

California

•Again, Thomas C., Alhambra
Campbell, Douglas B., San Jose
Corallo, Richard A., Livermore
Davidson, Otto C., Moffett Field
•Fall, Claire E., Fullerton
Fogarty, David J., Monterey Park
Greenwood, Whitney L., La Habra
Jones, Gilbert A., Los Angeles
Lundberg, Raymond B., Menlo Park
Olander, Robert G., Granada Hills
Strohm, James T., Hawthorne
•Swanson, Philip J., San Diego

•Promotion to Member or Affiliate.

Connecticut

BREGANTINI, ROBERT R., Uncasville
CLADIS, GEORGE H., Newtown
CUMMINGS, WILLIAM G., Windsor
DANA, DONALD P., Hartford
•HAINES, FRANK D., Windsor
SIMEONE, JOHN, Milford

Florida

•CROWLEY, FREDERICK R., Largo

Georgia

•WATSON, LIONEL A., Atlanta

Illinois

ANDERSON, GEORGE E., Chicago
BROWN, RALPH R., La Grange
•CLEMENS, OGDEN A., JR., Chicago
COMERFORD, WILLIAM H., JR., Bellwood
•FRIEDERICH, ALLAN G., Urbana
HANSON, WILLARD B., Argonne
JOHANINGSMEIR, HENRY M., Waukegan
MASKARA, PASHUPATI N., Champaign
NEUKRANZ, DONALD W., Evanston
SHULMAN, YECHIEL, Evanston
VLACIHA, LEONARD R., Berwyn
WAGNER, WILLIAM D., La Grange
WOMELDORFF, PORTER J., Decatur

Indiana

CLACK, RANDALL G., Indianapolis
GABREK, FABIJAN, Fort Wayne

Iowa

WHITE, WILLIAM V., Cedar Rapids

Kansas

CLARK, HAYNES, Wichita
•UMHOLTZ, ROBERT C., Lawrence

Kentucky

•MOSELEY, MARVIN J., JR., Paducah

Louisiana

•YANUS, GEORGE A., Chalmette

Maryland

FREESTONE, LEONARD J., Adelphi
•ZAHN, ALBERT M., Lutherville

Massachusetts

CHIVERS, ARTHUR S., Watertown
•CUNNEEN, WILLIAM J., West Roxbury
•GUNBY, FRANK M., JR., Winchester
HERBERT, ROBERT W., Springfield
PANOSIAN, JERAULD O., Lynnfield
ROBERTS, KENNETH P., Cambridge

Minnesota

BRENNA, LLOYD J., St. Paul
WOOD, HAROLD R., Rochester

Missouri

SLAY, WILLIAM C., St. Louis

Nevada

GRIMM, ROBERT J., Mercury

New Jersey

BLACK, RICHARD I., Closter
LEVERETT, JAMES H., Hackensack
LYONS, JOHN S., Metuchen
RADFORD, JAMES, East Orange
•RHODES, RICHARD, Plainfield
•SEAMAN, RICHARD D., Wyckoff

New Mexico

FORD, CLARENCE Q., University Park

New York

ADAMS, RICHARD F., Schenectady
ADAMS, ROBERT EARL, Hudson
•BURGER, EUGENE, Yonkers
CHERNJAVSKY, SERGEJ T., Rochester
•DIZER, JOHN T., JR., Utica
GERO, GEORGE, White Plains
GILBERT, JOSEPH, New York
KUEBLER, FREDERICK C., Brooklyn
MARBLE, THEODORE F., Schenectady
•MIRABELLA, FRANK J., Brooklyn
MOSKAL, JOHN A., Rochester
MULDOWNEY, JOHN J., New York
MURRAY, HAROLD J., Fairport
•SCHNEIDER, MELVIN, New York
VOLKMAR, DANIEL S., New York
WHEELER, WENDELL J., Endicott

North Carolina

BOYD, GORDON D., Raleigh
PEARSON, EDWIN J., Goldsboro

Ohio

•BEZBATCHENKO, MICHAEL, Akron
•ELDER, LOWELL L., Columbus
ENDRIZAL, KENNETH J., Lorain
EVANS, RALPH E., Monroe
KLEIZA, ALBERT E., JR., Copley
LIBBY, EDWIN L., Coshocton
SEXTON, DONALD L., Columbus
WILLIAMSON, ROBERT L., Toronto

Oklahoma

PLATNER, DEE E., Bartlesville

Pennsylvania

•BRICKMAN, ARTHUR D., State College
CASTER, THEODORE J., Yeadon
ERICKSON, CHARLES D., Erie
EVANS, ROBERT A., Pittsburgh
•GREEN, LOUIS D., Pittsburgh
HOBSON, RAYMOND G., Pittsburgh
JACOBOSKY, GILBERT G., Wilkes-Barre
KAUFFMAN, NED P., Dornsife
LEE, ALAN Y. H., Broomall
LEWIS, JOHN C., Philadelphia
NIECE, FULTON K., Devon
RAMASESHAIAH, RANGAVAJJHALA, Pittsburgh
THOMAS, DAVID R., Pittsburgh
TYSON, REUBEN K., Abington
WILDER, ARTHUR B., Pittsburgh
ZANDMAN, FELIX, Phoenixville

South Carolina

BENNETT, SIDNEY C., 3RD, Hartsville
POOLE, CHARLES M., Piedmont

Texas

ALFORD, THOMAS R., Genoa
•EMMETT, ALBERT E., Fort Worth
•FILBAN, THOMAS J., JR., Houston
KAPPLER, RUBIN E., Baytown
LEDWIG, JEROME L., Beaumont
LINDHOLM, ULRIC S., San Antonio
NOACK, MELVIN R., Beaumont
•SPIKES, ROBERT F., Amarillo
STAPH, HORACE E., San Antonio

Virginia

BENSON, DAVID B., Newport News
•SALOT, WILLIAM J., Colonial Heights
VALDRIGHI, NICHOLAS P., Richmond

Washington

BROWNE, OSCAR M., JR., Seattle
FLEMING, LYNN M., Pullman
WHITEHILL, ARTHUR F., Seattle

West Virginia

BISHOP, ARLEN L., Charleston
O'NEIL, WILLIAM E., So. Charleston
•SHANKS, CLARENCE D., JR., Charleston

Wisconsin

CHONG, JUAN P., West Allis
•COOK, EUGENE B., Hales Corners
GUPTA, CHANDRA P., Madison
HAZELOOP, CHRISTIAAN, Milwaukee
HUNT, GORMAN E., Milwaukee
SCHLINTZ, JOHN H., Hales Corners
WILSON, ALLAN E., West Allis

Foreign

•ADAMS, JAMES B., Don Mills, Ont., Canada
•BANERJEE, SUDHIR K., Kirkee, Poona, India
BASSETT, MICHAEL B., Three Rivers, P. Q., Canada
BOTERO, CARLOS A., Bogota, Colombia, S. A.
COLBORNE, WILLIAM G., Windsor, Ont., Canada
•HARRIS, ARTHUR B., Riverside, Ont., Canada
•HENNING, ROBERTO A., Buenos Aires, Argentina
KUMAR, VENKATRAMAN K., Secunderabad (DN), India
KWAN, SENG, Naha, Okinawa
LUGO, LUIS F., Bogota, Colombia, S. A.
MANSELL, IVOR, Montreal, P. Q., Canada
MOHAN, TELIKICHERLA R., Khargpur, India
MORGAN, DAVID B., Montreal, P. Q., Canada
•MULLER, HENDRIK L., Eindhoven, the Netherlands
RAO, DRAKSHARPU N., New Delhi, India
SASTRY, VUPPULURY G., Dayal Bagh (Agra) U. P., India
•SCHIECK, ROBERT R., Thorold, Ont., Canada
SPAN, PABLO R., Mexico, D. F., Mexico

OBITUARIES

Bancroft Gherardi Braine (1871–1959), retired engineer, Montclair, N. J., died in the fall of 1959, according to a notice received recently by the Society. Born, Navy Yard, Brooklyn, N. Y., March 19, 1871. Education, ME, Stevens Institute of Technology, 1893. Mr. Braine was retired from Poor and Co., New York, N. Y. Since 1897 he had been associated with the Continuous Rail Joint Company of America, Newark, N. J., which merged with Poor and Co. In 1902 he also became secretary and treasurer of the Essex Co., Newark. He had previously been assistant engineer with the Otis Engineering Co. Assoc-Mem. ASME, 1896; Mem. ASME, 1905.

Harry Cadwallader, Jr. (1881–1960), president, Standard Shop Equipment Co., Philadelphia, Pa., died, May 7, 1960. Born, Philadelphia, May 8, 1881. Parents, Harry and Mercy E. (Hill) Cadwallader. Education, ME, Temple Univ., Philadelphia, 1908; attended Univ. of Pennsylvania. Married Blanche Kapal, 1929; two children. An inventor and manufacturer, Mr. Cadwallader created the CAD Bolt for T-slots of machine tools. In 1919, he formed the Standard Shop Equipment Co., manufacturer of set-up appliances for machine tools. He was an early associate of Gen. John Tallaferro Thompson, inventor of the Thompson machine gun, while working with the Remington Arms Co., Eddystone, Pa., from 1916 to 1919. During the earliest part of his career after 1900, he also was an associate of Carl G. Barth, consulting engineer and expert in shop management, who helped develop the Taylor System of Shop Management. In this field, Mr. Cadwallader worked with machine-shop methods for the Jamaica Government Railway in Kingston, Jamaica, B. W. I., in 1909, and in the following few years developed equipment design as a machine designer with the U. S. Government in the Panama Canal Zone. Later, after returning to the U. S. A., he worked as an industrial engineer with the Continental Motor Mfg. Co., in Muskegon and Detroit, Mich., before beginning his association with Remington Arms and forming his own company. For his work in the Panama Canal Zone, he received the Panama Canal Medal in 1911. In 1926, he received two International Sesqui-Centennial Exposition Medal awards, one for the CAD T-slot and one for set-up appliances for machine tools. Mem. ASME, 1913. He was a member of ASTE, Builders of the Panama Canal, and The Engineers Club of Philadelphia. Surviving is his wife, Blanche of Solebury, Bucks County, Pa.; his son, Gouverneur; and a daughter, Mrs. W. Herrstrom, Hialeah, Fla.

James Edward Candlin, Jr. (1908–1960), technical assistant to the director of the research and development department, Pullman-Standard Car Mfg. Co., Hammond, Ind., died in 1960 according to a notice received by the Society. Born, Chicago, Ill., Jan. 16, 1908. Parents, James Edward and Elizabeth (Otto) Candlin. Education, graduate, Pullman Tech., 1924; Armour Institute of Technology, 1928. Married Marjorie Sarah Dick, 1929; children, Marilyn, Joyce, and James Edward, III. Mr. Candlin began working for the Pullman-Standard Company in 1924, spending his entire career with the organization. He worked on the design of the first lightweight box car of alloy steel in 1935, exhibiting this car and a passenger car of the same material in Atlantic City in 1937. He continued working on the development of passenger and freight cars and in 1943, was made assistant to the chief engineer with additional sales engineering responsibilities. During the later years of his career, he had charge of research and development, structural design, stress analysis, and testing. He held many railroad car patents, and coauthored the article "Design of Underframes for All-Welded Railroad Pass Cars," published in *The Welding Journal* in 1943. It won first prize in the railway division of the Lincoln Foundation contest in 1944. He also received Lincoln Foundation awards in 1942 and 1947. Mem. ASME, 1946. He also was a member of ASTM, SESA, AWS, and the Western Railway Club. He was a registered professional engineer in Illinois.

Henry Troth Coates (1878–1960), president, Henry T. Coates and Associates, Clinton, N. J., died, Dec. 6, 1960. Born, Bryn Mawr, Pa., Jan. 29, 1878. Parents, Joseph Hornor and Elizabeth Gardner (Pottsfield) Coates. Education, ME, Cornell Univ., 1900. Married Florence Thomas, 1906; children, George M., 2nd; Barbara H., and Roger M. Coates, and Marion D. Hemphill (stepdaughter). Mr. Coates worked with the Pennsylvania Railroad Co., until 1916, when he became president and general manager of the Philadelphia Brass Co., which he organized and developed. In 1919, he went with the Edward G. Budd Mfg. Co., Philadelphia, as production superintendent and construction engineer. Later, he held the same position with the Commonwealth of Pennsylvania, in Harrisburg, at which time he supervised the erection of the state capital building. In 1923 he joined the Dairymen's League Co-operative Association, in New York City, as a building agent and director of purchases for the association's 250 plants, remaining there for more than two

decades. He held several patents, and wrote numerous short articles on coal. He also co-authored a chapter in "Small Plant Management," published by McGraw-Hill. Mem. ASME, 1927. He did ASME committee work on specifications for clean bituminous coal, on standard inspection of motor vehicles, and on the selection and care of leather belting. He was an ASME representative on the American Standards Association. He was a member of NSPE and the National Association of Purchasing Agents, and was past-president of the Association of Purchasing Agents of New York. He was a registered professional engineer in New York and New Jersey.

Myron Lee Crater (1906–1961), chief steam-plant engineer, Public Service Dept., City of Glendale, Calif., died, Feb. 24, 1961. Born, Ravenwood, Mo., Aug. 13, 1906. Parents, Alfred Bruce and Effie (Davis) Crater. Education, BS, California Institute of Technology, 1932. Married Mary Elizabeth Hunt, 1933; one daughter, Marjorie Ann. Mr. Crater entered municipal service in 1933 as a steam-plant operator in the light and power department of the City of Pasadena, Calif. He began working for the City of Glendale in 1940, gaining civil service status there as a chief steam-plant engineer. Assoc-Mem. ASME, 1933; Mem. ASME, 1945. He was an ASME Los Angeles Section executive committee member, 1944–1945.

Charles Benjamin Curtiss (1886–1961), retired mechanical engineer, died, Bay City, Mich., March 15, 1961. Born, Bay City, Feb. 21, 1886. Parents, Charles B. and Georgianna (McGraw) Curtiss. Education, The Hill School; ME, Cornell Univ., 1909. Married Laura Knaack, 1929; children, Charles B., Jr., and Philip F. Mr. Curtiss worked steadily for three decades with the Bay City Foundry and Machine Co., starting as a sales manager in 1919. He became a company proprietor in 1927. His work with the company had its beginning in 1917, but was interrupted by World War I. At that time, he entered the Chemical Warfare Service of the U. S. Army, spending about a year at Edgewood Arsenal in charge of power-plant and evaporator building. Mr. Curtiss also worked eight years for The Wickes Boiler Co., Saginaw, Mich., before joining the Bay City Foundry. In addition to his work with the foundry, he was connected with the Defoe Shipbuilding Co., Bay City, from 1941 to 1943, and before his retirement, worked with Valley Welding and Boiler Co. He specialized in heavy duty winches for motor trucks, holding a number of patents in that field. Assoc-Mem. ASME, 1915; Mem. ASME, 1923. He also was a member of SAE and the Engineering Society of Detroit, and was a registered professional engineer in Michigan.

Henry Charles Dinger (1876–1960), retired consulting engineer, New York, N. Y., died, November, 1960, according to a notice received by the Society. Born, Eau Claire, Wis., March 2, 1876. Parents, Charles W. and Magdalene Dinger. Education, graduate, U. S. Naval Academy, 1898. Married Rose Sadlier (dec.), 1907; one child, Francis. Married 2nd, Gertrude Mack, 1917; children, Helen Josephine and Henry Charles, Jr. Captain Dinger made his career in the U. S. Navy. As a junior officer from 1898 to 1903, he went to sea on various vessels, among them the *USS Columbia, USS Celtic*, and the *USS Yorktown*. Then, with the Bureau of Engineering in Washington, D. C., he helped develop turbines for naval use, working on designs for fast cruisers. Before going to sea again in 1910 as commanding officer of the *USS Drayton*, he worked as a chief engineer out of the Navy yards in Norfolk, Va. He was commanding officer of the *USS Maumee*, a diesel tanker, in 1918. He retired from the Navy in 1930, and several years later began working as a consultant on corrosion problems, boiler operation, and feedwater treatment in New York City. He authored the book "Care and Operation of Naval Machinery," in 1910, and wrote numerous other articles on engineering subjects. Mem. ASME, 1924. A member on ASME committees, he worked on mechanical gearing and feedwater treatment, and was chairman of the ASME Committee on diesel fuel oil specifications, 1928–1930. He was a member and a former secretary of the American Society of Naval Engineers, and served as editor of the society's journal from 1908 to 1910 and again in 1914. He also was a member of the American Society of Naval Architects and Marine Engineers.

Warren Errett East (1888–1960), retired engineer, died, Madison, Wis., Nov. 19, 1960. Born, Bement, Ill., June 2, 1888. Parents, Homer Aden and Mary (Thompson) East. Education, BS, Univ. of Illinois, 1910. Married Rachel Jane Brown, 1916. Mr. East was a sales engineer. He joined Bailey Meter Co., Cleveland, Ohio, in 1918, and was with the company until 1927, initially as manager of the Chicago office and then as manager of the Western district. Subsequently, he went with Fuller Lehigh Co., Chicago, where he was manager of the Chicago sales territory until 1931. Then he joined the Babcock & Wilcox Co., Chicago, as a sales engineer, remaining there until his retirement in 1958. A graduate in electrical engineering, he served apprenticeships at the beginning of his career with Westinghouse Electric and Mfg. Co., and Westinghouse Machine Co., East Pittsburgh, Pa. Early in his career he also worked with the Mineral Point Public Service Co., Mineral Point, Wis., and the Toledo Railway and Light Co., Toledo, Ohio. After retirement, he made his home at Mineral Point. Assoc-Mem. ASME, 1919; Mem. ASME 1935. He was a member of the ASME Chicago Section Membership Committee. He was a member of Eta Kappa Nu, electrical engineering honorary, and the Engineers Club of Chicago, and was a registered professional engineer in the state of Illinois. Surviving is his wife, the former Katherine Davies; an uncle, Carl Thompson, Bement, Ill.; and three cousins, Mrs. Nellie Calhoun, Farmer City, Ill., Miss Florence East, Cerro Gordo, Ill., and Jack Thompson, Miami, Fla.

Harry Stanley Ford (1893–1961?), retired vice-president and general manager of the Bigelow-Liptak Corp.; president, Bigelow-Liptak Export Corp. and Bigelow-Liptak Realty Corp.; president and director, Bigelow-Liptak of Canada, Ltd., Toronto, Ont.; and Bigelow Liptak de Mexico, S. A., died recently according to a notice received by the Society. Born, Fairmount, Md., Feb. 23, 1893. Parents, John Henry and Melissa Catherine Ford. Education, BS, Univ. of Maryland, 1914. Married Bernice Lewis, 1922; children, Jane Ellen and H. S. Ford, Jr. Mr. Ford joined the Bigelow-Liptak Corp., producer of industrial furnace enclosures, in 1930. Before that he had worked for more than a decade with the R. H. Beaumont Co., Philadelphia, Pa., advancing from a drafting position through sales engineer and district manager to Eastern sales manager. From 1917 to 1919, he was with the U. S. Navy as a junior engineer, having completed a special course in mechanical and marine engineering at the U. S. Naval Academy. He was awarded the Alumni Medal in Engineering at the Univ. of Maryland in 1914. He authored some papers on coal-handling equipment. Assoc-Mem. ASME, 1921; Mem. ASME, 1935. He was a member of the executive committee of the ASME Detroit Section from 1946 to 1949. He was a member of the Engineering Society of Detroit, and a member of the Department of Commerce Committee of the Conference of American Small Business Organizations (CASBO).

Charles Franklin Frede (1875–1961), retired vice-president, Commonwealth Steel Co., Granite City, Ill., died, Morton Plant Hospital, Belleair, Fla., March 2, 1961. Born, Brookville, Ind., Nov. 30, 1875. Education, mechanical engineering, ICS. Mr. Frede was associated with the Commonwealth Steel Co. in various capacities since 1902. He rose through the positions of chief draftsman, mechanical engineer, and manager of engineering, becoming works manager of the Commonwealth Division, a part of the General Steel Castings Co., and then vice-president. He was retired in Belleair, Fla. Mem. ASME, 1918. Surviving are his wife, Elizabeth McKenzie Frede and a sister, Mrs. Charles Adam, Mylan, Ind.

Perry John Freeman (1881–1961?), retired consulting materials engineer, Florence, Ala., died recently according to a notice received by the Society. Born, Lilly Chapel, Ohio, July 25, 1881. Parents, John Carter and Cynthia (Olney) Freeman. Education, BS(ME), Univ. of Illinois, 1907; ME, 1916. Married Clotilde Ligon Reid, 1914; children, Eva Margaret, Mildred Reid, and Donald Eugene. Mr. Freeman was principal materials engineer for the Tennessee Valley Authority, Knoxville, Tenn., from 1934 to 1951. He approved specifications for materials and methods of manufacture of all hydraulic power plants, generators, steam plants, substations, transmission lines, and operating machinery for river locks of the TVA. Inspection trips for the TVA took him to 28 states and more than 200 cities in the U. S. A. Mr. Freeman came to the Authority after a number of years with the Pittsburgh Testing Laboratory in Pittsburgh, Pa., and with the Bureau of Tests and Specifications, Department of Public Works, in Allegheny County, Pa. In both positions, he had charge of specifications and methods in the construction of highways, bridges, buildings, dams, and power plants. Previously, he had taught mechanical engineering at the Univ. of Pennsylvania, 1907–1910; been superintendent of shops at the Univ. of Illinois, 1910–1912; and assistant professor of hydraulics and mechanics at Kansas State College, 1914–1916. Mr. Freeman retired in 1951, although retaining a special services contract as head materials engineer with the TVA until 1953. He was a consulting research and materials engineer from 1953 to 1957. He authored a number of articles on methods for testing materials and controlling their quality, some of which were published in the Proceedings of ASTM, and of the American Concrete Institute, and the *Revue Universelle Des Mines*, Liege, Belgium, as well as many other publications. He coauthored a report on a survey of paving conditions in the U. S. A. Jun. ASME, 1908; Assoc-Mem. ASME, 1914; Mem. ASME, 1919. He was a member of ASCE, ASTM, and the American Concrete Institute as well. He was a licensed professional engineer in the Commonwealth of Pennsylvania.

John Edwin Fulweiler (1883–1960), retired mechanical engineer, died, Cheshire, Conn., Dec. 21, 1960. Born, Philadelphia, Pa., Feb. 16, 1883. Parents, Peter Conrad and Emma Sheble (Fisher) Fulweiler. Education, BS(ME), Univ. of Pennsylvania, 1906; ME, 1909. Married Helen Ray Walker, 1921. Mr. Fulweiler was a partner in the industrial consulting engineering firm of Schmid and Fulweiler, organized in 1938. Before then he worked with a number of firms, among them the W. P. Mackenzie Co., Philadelphia, Pa., where he was vice-president, 1919–1927; the Foster Wheeler Corp., New York, N. Y., 1932–1933; and the General State Authority, Harrisburg, Pa., 1937. He also was a member of Fulweiler and Perkins Associates, consulting engineers in Philadelphia, in 1907. Before retiring in 1958, he was a mechanical engineer with the Public Works Department, State of Connecticut, in Hartford. A Navy veteran of World War I, he served as a captain on the mine-sweeper *Biscayne Bay*. He was an officer of the deck on the troopship *Kaiserine Augusta Victoria*, returning troops to the U. S. A. from Europe. Mr. Fulweiler invented a method of making spiral flue retarders used in gas boilers, a grate for fine coal, a thermostatic gas valve, and a dust separator for stack gases. Assoc-Mem. ASME, 1908; Mem. ASME, 1913. He was a registered engineer in Pennsylvania and New Jersey. Surviving is his wife, Helen.

Robert Maurus Goetz (1934–1961), process engineer, Automatic Electric Co., Northlake, Ill., died, Jan. 18, 1961. Born, Chicago, Ill., May 29, 1934. Education, BS(ME), Illinois Institute of Technology, 1956. Before joining the Automatic Electric Co., Mr. Goetz was a development and research engineer with Beardsley and Piper Division of Pettibone Mulliken Corp., Chicago. He worked on resin-coated sands for the corporation, which manufactured foundry equipment. Assoc. Mem. ASME, 1956.

Burr Franklin Gongwer (1896–1961), vice-president, Firemen's Mutual Insurance Co., New York, N. Y., died, Feb. 25, 1961. Born, Cleveland, Ohio, Aug. 1, 1896. Education, attended Univ. of Pennsylvania and Western Reserve Univ., Cleveland, Ohio. With Fireman's Mutual Insurance Co. since 1926, Mr. Gongwer was first employed as an engineer and then assistant vice-president before becoming vice-president in 1934. He had worked with insurance, particularly fire-protection insurance, since 1918, when he was a superintendent in the Improved Risk Department of the State of Michigan. At that time, he was on the advisory committees of the National Fire Protection Association and the National Board of Fire Underwriters and Underwriters' Laboratories. Later, he became a representative of the Western Factory Insurance Association, Michigan, on field work, supervision of fire protection, and inspection of insured plants. Mr. Gongwer advised clients on construction, special devices, and fire-protection apparatus for large industrial plants. He began his career as a helper-fitter and tank-erection foreman for the General Fire Extinguisher Co., Cleveland, and then became an inspector-engineer, examining plants for the Michigan Inspection Bureau and the War Industries Board. Affiliate ASME, 1942.

Hiram Britton Hartwell (1873–1961), mechanical engineer, Crosby Steam Gage and Valve Co., Boston, Mass., died, March 10, 1961. Born, Watertown, Mass., June 30, 1873. Education, BS, Massachusetts Institute of Technology, 1896. Mr. Hartwell was with Crosby Steam Gage and Valve Co., since 1898 when he started as a draftsman. After a period there he became head of the production engineering department. He had previously been with the Boston Woven Hose and Rubber Co., where he had charge of boiler and engine tests. Jun. ASME, 1903; Mem. ASME, 1939. Surviving is his wife, Carol, Norwood, Mass.

William Steinert Hill (1888–1961?), superintendent, Street Lighting Construction, City Engineering Division, City of Seattle, Wash., died recently according to a notice received by the Society. Born, St. Joseph, Mo., Jan. 19, 1888. Parents, John C. and Margaret (Light) Hill. Education, BS, Univ. of Missouri, 1910. Married Martha Ann Goertz, 1935; children, Jane M. and William S., Jr. Mr. Hill worked for a number of railway, light, and power companies in Missouri after graduation, and then moved north to Milwaukee, Wis., where he worked with similar firms, chief among them the Milwaukee Electric Railway and Light Co. He designed overhead railway trolley construction in business districts and had charge of all country extension work. He helped plan Milwaukee's 8800-street-lamp lighting system in 1915-1916. Returning to Missouri in 1916, he went to work for the Springfield Gas and Electric Co., and for the Springfield Traction Co. as superintendent of the light and power department, before moving to Arkansas to work with the Arkansas Power and Light Co., in Stuttgart. In 1922, he journeyed to the Pacific Northwest where he settled in Aberdeen, Wash., eventually moving to Seattle. Assoc-Mem. ASME, 1918; Mem. ASME, 1935. He was a member of AIEE, and a registered electrical and mechanical engineer in the State of Washington.

George Harrison Houston (1883–1950?), partner, George H. Houston and Co., New York, N. Y., died about ten years ago, according to a notice recently received by the Society. Born, Covington, Ky., Jan. 4, 1883. Parents, Charles R. and Elizabeth H. (Mapes) Houston. Education, attended Univ. of Cincinnati. Married Mary Stuart Hoge, 1909; children, Peyton H., George H., and Mary Stuart. A management consultant and industrial engineer, Mr. Houston headed a number of firms during his career. Among these were the Wright-Martin Aircraft Corp., where he was president, 1917–1919; the Wright Aeronautical Corp.; the Marlin-Rockwell Corp.; the General Sugar Co.; and the Cuban Dominican Sugar Co., all of which he served as president between 1919 and 1927. He was a consulting engineer in New York City from 1927 to 1929, and then became president of The Baldwin Locomotive Works and subsidiaries, Philadelphia, Pa. Mr. Houston started his career in 1899 as a machinist apprentice in the shop of the Houston, Stanwood and Gamble Co., Covington, Ky. When he left the company in 1901 he was shop superintendent. Later, he became production superintendent of the Root and Van Dervoort Engineering Co., and several years thereafter became a partner in the firm of Jamieson and Houston, where he was associated until 1921. Mem. ASME, 1913.

Russell Compton Jones (1884–1961), retired president and director, Griscom-Russell Co., New York, N. Y., died, Sarasota, Fla., Feb. 20, 1961. Born, Fort Shaw, Mont., April 30, 1884. Parents, Col. Francis Bacon and Jennie (Little) Jones. Education, ME, Columbia Univ., 1907. Married Isabel Helen Floyd-Jones, 1911. Mr. Jones was engaged in experimental engineering from the beginning of his career. He joined the Griscom-Russell Co., as an engineering salesman in 1909, becoming manager of the company's Canadian branch in 1912. Mr. Jones invented the submerged-type Reilly Evaporator and the Multiwhirl Lubricating Oil Cooler. Both units were used by the U. S. Navy and Merchant Marine. He also designed numerous other auxiliaries of this type of apparatus. Before he began specializing in evaporative steam condensers and marine auxiliaries, Mr. Jones was with Charles S. Bradley and Sons, consulting engineers in New York City, where he did experimental work in the fields of high temperature, wet metallurgy of copper and gold, and electrical and mechanical engineering. He held a number of patents in the field of steam engineering. Jun. ASME, 1912; Mem. ASME, 1919. He was a member of the American Society of Marine Engineers and Naval Architects and of the Society of Naval Engineers. Surviving is his wife, Helen, three sons, Griffith ap Jones, U. S. Embassy, Lagos, Nigeria; DeLancey Floyd-Jones, Shaker Heights, Ohio; and Christopher Peter, Wayland, Mass.; and one daughter, Mrs. William M. (Valerie Compton) Materne, Stamford, Conn.

Joseph Kaye (1912–1961), professor, Massachusetts Institute of Technology, died, March 20, 1961. Born, Malden, Mass., Nov. 16, 1912. Parents, Nathan and Ida (Bander) Kaminsky. Education, SB, M.I.T., 1934; PhD, 1937. Married Ida Surgecoff, 1940; children, Leonard, Harvey, Sidney M., and Charles D. An A. D. Little postdoctorate fellow at M.I.T., Professor Kaye did research in the mechanical-engineering department there before becoming an instructor in 1940. He advanced to assistant professor in 1944, associate professor in 1948, and professor in 1955. He was a consultant to industry and government, and director of M.I.T.'s research laboratory for heat transfer in electronics since 1952. He owned the Joseph Kaye and Co., Brookline, Mass. A busy technical writer, he coauthored the books "Thermodynamic Properties of Air," 1945, and "Gas Tables," 1948, as well as writing numerous technical papers, a number of reference articles, about 40 industrial and government reports on aircraft power plants, heat transfer, turbine design, and thermodynamics; and many book reviews. Jun. ASME, 1941; Mem. ASME, 1952. He was past-chairman of the Applied Mechanics group of the ASME Boston Section. He was a fellow of AAAS, and a member of the American Chemical Society, the American Physical Society, ASEE, the Institute of Aeronautical Sciences, Sigma Xi, and Pi Tau Sigma. He was a registered engineer in the Commonwealth of Massachusetts.

Edgar Homer Kendall (1890–1961), president, Kendall Contracting, Inc., Alliance, Ohio, died, April 5, 1961. Born, Alliance, Ohio, Nov. 29, 1890. Parents, David and Elizabeth Q. Kendall. Education, attended Mt. Union College, Alliance. Married Eileen Bowman, 1916; one daughter, Nancy Elizabeth. Mr. Kendall worked for a number of steel and machine companies before organizing Kendall Contracting, Inc. He also served as vice-president of the Alliance Machine Co., Alliance, Ohio, 1924–1929, the company where he started his career in 1908. Other organizations with which he was connected were the Carnegie Steel Co., Braddock, Pa.; the Otis Steel Co., Cleveland, Ohio; the Standard Steel Works Co., Lewistown, Pa.; the Erie Forge and Steel Co., Erie, Pa.; and the English Steel Co., London, England, where he consulted on forge equipment during 1929–1930. He held several patents on cranes and forging machinery. Jun. ASME, 1916; Mem. ASME, 1926. He was vice-chairman of the ASME Erie Section in 1923.

Harry J. Kyzivat (1912–1961), methods engineer, Parke Davis Co., Detroit, Mich., died, St. John's Hospital, Detroit, Feb. 5, 1961. Born, Oklahoma City, Okla., Dec. 19, 1912. Parents, Joseph and Julia (Rubener) Kyzivat. Education, IE, Wayne State Univ., 1958. Married Evelyn Wolfe, 1941; one son, Paul Harry. Mr. Kyzivat attended the University of Detroit from 1933 to 1935. Assoc. Mem. ASME, 1958. Surviving are his wife and son, Grosse Pointe, Mich.

Richard Coke Marshall, Jr. (1879–1961), consulting engineer, Washington, D. C., died, March 12, 1961. Born, Portsmouth, Va., March 13, 1879. Parents, Richard and Mary Catherine (Wilson) Marshall. Education, BS, Virginia Military Institute, 1898. Married Mary Louise Booker, 1903; children, Laura Winder, Marshall Fisher, and Richard C., 3rd. Mr. Marshall served as a captain in the 4th U. S. Volunteer Infantry in Cuba in 1898–1899, and then taught mathematics at Virginia Military Institute before joining the U. S. Army in 1902. He entered the Coast Artillery School at Fort Monroe and, after graduating with honors in 1904, taught there. During his early career in the Army, he helped establish base lines for range finding and other coast artillery work in New York Harbor and later in Chesapeake Bay. He was an assistant officer of construction and repair in the Quartermaster General's Office, War Department, Washington, D. C., from 1908 to 1912, and again from 1915 to 1916. Rising to Brigadier General in 1918, he was chief of the Construction Division, U.S. Army, during World War I. He continued his Army career as Brigadier General, Officers Reserve Corps, until 1928. He had practiced as a consulting engineer since 1933. Mem. ASME, 1919. He was a member of AICE, ASCE, AIEE, and the Washington Society of Engineers.

Carlyle Brady Martin (1905–1961), engineer, Fostoria Glass Co., Moundsville, W. Va., died, Feb. 1, 1961. Born, Harrison County, Mo., Aug. 27, 1905. Education, BS, Carnegie Institute of Technology, 1929. Mr. Martin was associated with Fostoria Glass Co. since 1929, when he joined the company as assistant plant engineer. At that time he worked on floor plans for machinery layouts, but took charge of all boiler and power-plant operation upon becoming plant engineer in 1935. He also designed and built machinery for special jobs in the manufacture of glass tableware, the company's product. Mem. ASME, 1948.

Rufus Sawyer Moncrief (1899–1960), superviser, Power Department, Southwestern Electric Power Co., Shreveport, La., died, Dec. 1, 1960. Born, Longstreet, La., Sept. 18, 1899. Education, graduate, Veteran's Administration Vocational School, 1923. Mr. Moncrief worked with the Shreveport Railway Co., Shreveport, La., during the period 1920–1925, operating power-plant equipment. He left that company in 1925 to join the Southwestern Gas and Electric Co. in Shreveport. He spent some time in various company power plants, although chiefly in the Arsenal Hill Plant where he was first a watch engineer and eventually progressed through the grades to chief engineer. In 1945, he was made superviser of power plants for the company. Mem. ASME, 1954. He was a member of the National Association of Corrosion Engineers.

Thorington Preston Plummer, Jr. (1926–1961), service engineer, Pigments Department, E. I. du Pont de Nemours & Co., Inc., New Johnsonville, Tenn., died, March 20, 1961. Born, Rochester, N. Y., May 1, 1926. Education, BSME, Clarkson College of Technology, Potsdam, N. Y., 1951. With the du Pont Co. since 1951, Mr. Plummer conducted studies of production equipment for design changes. His work primarily concerned machine tools, conveyers, dryers, and leachers. Before joining the company, he had worked summers, from 1948 to 1951, for the New York Central Railroad in Watertown, N. Y. Assoc. Mem. ASME, 1955.

Elmer F. E. Schmidt (1889–1959), natural gas consultant, Dallas, Texas, died, Jan. 15, 1959, according to a notice recently received by the Society. Born, Binghamton, N. Y., May 15, 1889. Parents, Max B. and Clara (Kelley) Schmidt. Education, CE, Cornell Univ., 1912. Married Lucille English Brawley; children, Charles Donnally and Elmer Frederick. Mr. Schmidt was associated with a number of fuel and gas companies before going into private practice. Chief among these was the Lone Star Gas Co., where he was general superintendent for several years, beginning in 1924. He also had worked with the Ohio Fuel Supply Co., Charleston, W. Va., and the Northwestern Ohio Natural Gas Co. He authored many articles on gas-industry problems that were published in trade papers. Assoc. Mem. ASME, 1919; Mem. ASME, 1929.

Daniel Joseph Sheehan (1899–1960?), managing director, Australian Division, Hyster Co., New South Wales, Australia, died, December 1960, according to a notice received by the Society. Born, Northampton, Mass., March 14, 1899. Parents, Timothy D. and Nora (Tooby) Sheehan. Education, BS(ME), Univ. of Michigan, 1921. Married Charline Sullivan, 1923; children, Paul, Daniel, John, and Nora. Married 2nd, Bernice Dougherty, 1953. A specialist in locomotive design, Mr. Sheehan worked for several railroads before joining the Hyster Co. of Portland, Ore., in 1946. Then, before taking over management of the Australian Division, he managed the general parts and service department of the company, whose products are lift trucks and tractor-mounted equipment. An engineer in railroading since 1923, when he worked with the Lima Locomotive Works, Lima, Ohio, he also worked for the Erie Railroad, Cleveland, Ohio; the Chesapeake and Ohio Railroad; and the Chicago and Eastern Illinois Railway Co., Danville, Ill. For several years after being graduated from the Univ. of Michigan, he taught mechanical engineering at Purdue Univ. Mem. ASME, 1939. He was a registered engineer in Illinois.

Arnold Smith (1916–1960), assistant tape production methods engineer, Minnesota Mining and Mfg. Co., St. Paul, Minn., died, Nov. 20, 1960. Born, Chicago, Ill., Dec. 9, 1916. Education, BBA, Univ. of Minnesota, 1948; BME, 1948. Mr. Smith joined Minnesota Mining as a junior engineer in the production-engineering department. Assoc. Mem. ASME, 1948.

Jack George Trawick (1904–1961?), owner, J. G. Trawick and Co., Birmingham, Ala., died recently according to a notice received by the Society. Born, Suez, Egypt, Feb. 28, 1904. Parents, George and Olga Nicolich Trawick. Education, attended Tulane Univ. Naturalized U. S. citizen, New Orleans, La., 1914. Married Gay Nell Sims, 1944; one daughter, Jessica. Mr. Trawick was a district representative in engineering sales for the Brown Instrument Division of Minneapolis-Honeywell Regulator Co., Birmingham, Ala., for more than a decade beginning in 1935. He was in charge of company activities regarding job installations in Alabama, northwest Florida, and southern Mississippi. He left the company in 1948 to operate his own business as a manufacturers' agent. Before associating with Minneapolis-Honeywell, Mr. Trawick was assistant superintendent for the Haden Lime Co., Houston, Texas. He had also been an assistant chemist for Trinity Portland Cement Co., Houston, and had done similar work for Southern Cotton Oil Co., Gretna, La. Assoc. Mem. ASME, 1955. He was a member of the Association of Iron and Steel Engineers.

Arthur Stanton Wells (1890–1960), consulting engineer, Chillicothe, Ohio, died, May 10, 1960. Born Bristol, Me., Nov. 22, 1890. Parents, Frank B. and Rachel (Thorp) Wells. Education, ME, Cornell Univ., 1914. Married Blanche Welsh Duncan, 1928; children, Arthur S., Jr., Dorothy D., and Margaret G. Mr. Wells was associated for many years with the Mead Corp., Kingsport, Tenn., whom he joined as plant engineer in 1926. At that time, he was assigned to modernize the company's steam plant. He gained experience for this work since 1915, when he went to work with John A. Stevens, Inc., Lowell, Mass., as a field engineer on steam-power plants for industrial establishments. Later, he also worked for the Holyoke Water Power Co. and the Champion Coated Paper Co., Hamilton, Ohio. Articles on power plants written by Mr. Wells appeared in *Power*, *Electrical World*, *Paper Mill News*, and *Paper Industry*. Mem. ASME, 1923. He was a member of AIEE.

David Daniel Zink (1900–1961?), director of operations, The Mayo Interests, Tulsa, Okla., died recently according to a notice received by the Society. Born, Charles City, Iowa, July 14, 1900. Education, attended Oklahoma A&M College. After gaining engineering experience with a number of companies in Missouri and other states, Mr. Zink organized his own office and staff in 1934 to consult on mechanical, electrical, and sanitary equipment for buildings. After five years with his own company, he briefly joined BOR Engineering Corp., Kansas City, Mo., and then entered the U. S. Army as a Captain, Armored Force. He served in Algeria, Tunisia, Italy, and France, and was promoted to Colonel, General Staff Corps in 1944. His war work earned him the Bronze Star, Legion of Merit, three battle Stars, and several official commendations. He resumed engineering practice in 1946 as chief mechanical and electrical engineer with George L. Dahl Architects and Engineers, working primarily in Dallas, Texas. He authored numerous articles for trade and technical magazines. Mem. ASME, 1948. He was president of the Oklahoma A&M ASME Student Section, as well as secretary of the school's engineering council and club. He was a member of ASHRAE, a charter member of the National Air Conditioning Council, chairman of the Kansas City Air Conditioning Council, and worked with the national ASHRAE committee on field research and tests in connection with ventilation and control of carbon monoxide in garages. A member of NSPE and of the Missouri and Texas professional engineering societies, he was a registered engineer in those states and in Oklahoma and Arizona.

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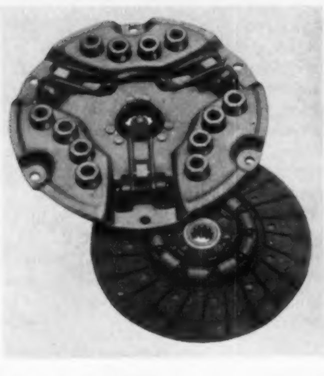


High-Speed Clutch

Rockford Clutch Div., Borg-Warner Corp. has announced its new dual-drive FA clutches. The spring-loaded clutches are specially designed to meet modern high-speed engine requirements. They are now available for a variety of tractor drives.

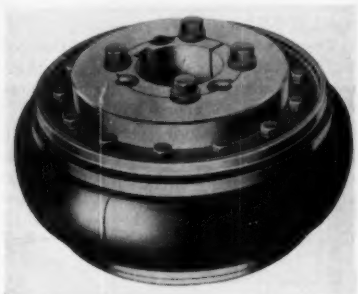
A counterbalanced release lever design permits high-speed operation without increasing pressure required to release and gives long bearing life. Rockford's patented antifriction roller action of the release levers gives instantaneous disengagement with minimum pedal pressure and longer lever life.

Dual-drive clutches contain a built-in provision for live power take-off. This low-cost auxiliary drive runs constantly from the flywheel through a splined hollow shaft. The new clutches have antirattle lever springs for quiet operation. Twelve powerful engagement springs, properly spaced over the facing area, assure maximum driving contact. **—K-1**

Slide Rule for Valves

A slide rule, which simplifies the task of sizing control valves for known conditions of flow, pressure, and so on, is now available from Robertshaw-Fulton's Fulton Sylphon Div.

The slide rule solves for C_v and corrects for steam quality, gas specific gravity and temperature, and liquids specific gravity and viscosity. Standard slide-rule scales A, B, C, and D are also incorporated. **—K-2**



Flexible Coupling

A heavy-duty, flexible-cushion coupling, largest in the Dodge Para-flex line, is available from Dodge Mfg. Corp., for applications with high torque requirements.

The new PX280 Para-flex has more than twice the torque capacity of the next smaller size, and features the standard tire-shaped flexing element to accommodate angular and parallel shaft misalignment, and to absorb end float, shock and vibration. The PX280 will handle 400 hp per 100 rpm. Its capacity at maximum recommended speed of 910 rpm is 3640 hp.

The new coupling is available from stock with taper-lock bushings for shafts up to 7 in. dia, or may be ordered bored-to-size for shafts as large as 9 in. **—K-3**

Floating Clinch Nut

Greater tolerances for mating assemblies and simplified installation methods are the important advantages offered to the user by the new floating clinch-nut design introduced by the Elastic Stop Nut Corp. of America. These self-retained clinch-type "blind" fasteners (Type NC4284) provide load-bearing threads in thin sheet-metal assemblies such as electronic chassis, instrument panels and cover plates. It is usually necessary for such fastenings to be located on the blind side of the work and they become inaccessible once the various components of the package are assembled. As a result, reliable performance is essential since these parts must remain securely "fixed" in position to permit rapid assembly and disassembly of the unit for inspection and maintenance.

The new self-locking nuts are manufactured both from carbon steel and 18-8 stainless in machine screw sizes No. 4, 6, 8, and 10. For each thread size a series of three baskets with alternate shank lengths of 0.040, 0.060 or 0.090-in. is offered for easy flush installation in sections of equivalent thicknesses. Locking device is a special red nylon insert which withstands temperatures up to 350 F. **—K-4**

Flange Bearing

A low-cost ball bearing in a flange-type iron housing is now available through Fafnir Bearing Co.

Of special application in the farm machinery and air-conditioning fields, the unit also meets the requirements of other machinery manufacturers. Known as the FLCT, this unit consists of a compact cast-iron housing with a standard inner-ring ball bearing and self-locking collar. It is interchangeable with Fafnir's 2-bolt Flangette stampings. The combination square and round bolt holes will accommodate carriage bolts or standard machine bolts. The FLCT is availabe in shaft sizes from $^{1}/_{2}$ to $1^{7}/_{16}$ in. od except for $^{13}/_{16}$ in. od. **—K-5**

Piston Pumps

Vickers Inc., Div. of Sperry Rand Corp., has announced the first of a line of angle-type piston pumps and motors rated for pressures to 5000 psi. A wide variety of controls, high-pressure capability, instant response to controlling signal, and reversible flow make the units usable in any application requiring high pressures and flows. A partial list of applications includes forming and extrusion presses, cargo winches, planer drives and log carriages.

The Vickers Series 120 units are available as either pumps or motors, with fixed or variable displacement. These pumps operate at 1200 rpm with atmospheric intake and at 1800 rpm with supercharging, permitting use of standard electric-drive motors. Pump delivery at these speeds is 120 gpm and 180 gpm, respectively. Maximum pressure rating of 5000 psi permits use of more compact components and assures reliability at normally encountered pressures. Maximum displacement is 23.7 cu in. per revolution, and maximum torque is 378 lb-in. per 100 psi. **—K-6**

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Triplex-Plunger Pump

A new pump, the PT-4 introduced by Gardner-Denver Co., offers the simplicity of compact design and the advantage of high volumetric efficiency. The PT-4 is a triplex-plunger pump which operates at 70 hp input at 400 rpm.

The pump is well suited for waterflood and salt-water disposal, the PT-4 fills many needs in general industry such as chemical, refining, and food-processing plants.

The low-pressure range of the PT-4 is from 510 to 1563 psi, while the high-pressure range maximum is 3000 psi. Plunger sizes are $3\frac{1}{2}$ down to $1\frac{1}{4}$ in. by 4-in. stroke, and plunger load is 4910 lb. Over-all weight is 1370 lb. **—K-7**

Quality Tracing Vellum

Ozatrace, a new fine quality tracing vellum, has been introduced by the Ozalid Div. of General Aniline and Film Corp. Developed for attractive visual appeal and superior strength, Ozatrace is reported to be the result of a brilliant new transparentizing resin which has been matched with finest grade 100 per cent unbleached rag paper. Ozatrace may be used as a highly durable tracing paper for engineering, tracing, architectural drawings, map reproductions, and for type-on masters for whiteprint, letterpress, or offset reproduction.

A slightly textured surface has been created in the base paper for good pencil "take." The surface will also accept drawing ink without skipping, feathering, or spreading. Pencil lines may be erased from one spot at least 10 times without damage to the drafting surface; ink lines may be erased at least three times.

Ozatrace is supplied in 16 lb weight, in 30, 36 and 42-in. rolls, and in all cut sheet sizes. Literature on this new high-quality tracing vellum is available. **—K-8**

Safety Stairway

The Bernard Gloekler North East Co., manufacturer of "Ridg-U-rak" storage rack systems, has developed a new application for its rack design. The company designed and erected, as part of its displays at recent Material Handling Shows, a stairway to an elevated platform. The platform provided a full view of the display floor and gave engineers a closer view of "Ridg-U-rak's" design features.

Plant engineers noted the unique "safety stairway" construction and asked for literature. So many requests were made that the BG engineers had to design the convenient safety stairway into the "Ridg-U-rak" line. The result is a portable type safety tread stairway that can be erected like a rack and relocated at any time. Full details are given in Catalog 110. **—K-9**

Lip Seal Inspecting Machine

Sealector, developed and manufactured by General Motors Research Laboratories, automatically inspects lip seals to find and reject potential leakers. Any seal that is too-large or too-small in lip diameter or lip pressure is a potential leaker. The Sealector can check up to 1200 seals-an-hour for proper diameters and pressures.

The Sealector checks the seals by clamping them in a series of three adapters and gaging the flow of compressed air past the seal lip. Air flow (at a constant pressure) between the seal and low and high diameter shafts checks the id. Air pressure necessary to produce a standard flow of air past the seal lip checks lip pressure. Each of the three checking stations (high diameter, low diameter, pressure) is followed by a reject station which ejects seals failing a test. The seals are carried through the stations by an air-operated turret table. The number of rejected and accepted seals are totaled on counters on the front of the machine.

The Sealector is 36 in. wide, 36 in. long, and 60 in. high, and weighs 700 lb. It uses 110 vac, 60 cycle current, and compressed air at 60 psi or more. Hand-operated machines that inspect diameter and/or pressure are also available. **—K-10**

Oil Seal

A standard design shaft-type oil seal that will satisfy the large majority of industrial, automotive, off-the-road, and farm equipment applications is now available from Chicago Rawhide Mfg. Co.

Designated as the CRS seal, it features significant improvements to users both in basic seal design, and in the new sealing-member compound used.

The seal is available in four standard configurations and is tooled for shaft sizes ranging from $\frac{1}{2}$ to 7-in. **—K-11**

Pressure Regulator

OPW-Jordan announces an extra sensitive pressure regulator. Available from stock in ductile iron (No. 160A) or bronze (No. 260A) in $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, and $\frac{3}{4}$-in. sizes. In a severe test on steam service with 20 psi inlet and 7 psi outlet, the valve showed a swing of only ± 0.1 psi. Pressure regulation is equal to piloted valves without the trouble associated with pilots. The pressure regulator is completely selfoperated, and is suitable for steam, water, air, oil, gas, or chemicals with a pressure control range from 0.5 to 125 psi. Stainless steel, self-cleaning and self-lapping sliding gate seats are standard (features tight shut-off). The regulator is suitable for 250 psi at 500 F with a maximum pressure drop of 175 psi and a minimum pressure drop of 3 psi. Complete engineering information, test results, photographs, features and prices are given in two-page PNB 5-61 and eight-page Catalog J160-1. **—K-12**

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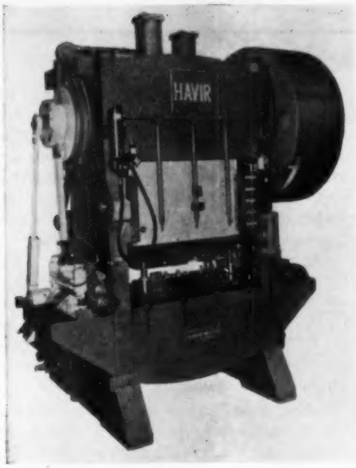

Automatic Press

Increased press and die life are two of the many features claimed for the new, heavy-duty 150-ton Havir Auto-Press announced by the Havir Mfg. Co., This high-speed automatic press has an exclusive cylindrical-type ram for precision alignment of die and ram with maximum ram rigidity. The company claims that this design increases die life up to 50 per cent over conventional presses.

The press has standard operational speeds of 70 to 210 strokes per min using an 18-in.-wide feed. Slower speeds can be ordered. The 150-ton Havir auto-feed is specially engineered for the press. By precision engineering of the feed for the Havir model alone, the manufacturer claims a longer life for the mechanism and more accurate stamping production, compared to many competitive models. The air clamped feeds prevent stock distortion and allow infinite controllable variations of roller pressure. Single or double feeds are available as optional equipment on the press.

Another feature is built-in shock mounts. They allow press operation on any reinforced-concrete floor without using special floating blocks or shock pits. Four heavy springs are built into each leg, and an air counterbalance helps nullify the weight of the ram to reduce vibration and crank bearing wear. **—K-13**

Gage Rods

Wales Strippit Inc. has introduced a positive locking, threaded gage rod as a new accessory for many of its self-contained units. A tapped hole is provided in the holders of the BN-$^3/_4$, BN-$1^1/_4$, CJ-1 and CJ-$1^3/_8$ units.

The positive locking, threaded gage rod can be accurately adjusted and then securely locked with a lock nut. These gage rods are now available as an accessory for the units mentioned. **—K-14**

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Line-Mounted Meters

Roots-Connersville Blower, Div. of Dresser Industries, Inc., has released information on line-mounted Rootsmeters. Line-mounted models are offered in 3000 and 7000 cfh (dial rate) for working pressures to 125 psig. The literature offered includes a brochure citing features of the meters and detailed specifications including construction features, dimensions and capacity ratings at various operating pressures.
—K-15

High-Performance Dashpots

A complete line of standard dashpots has been announced by Taylor Devices, Inc., specialists in compressible material devices.

These patented high-performance and high-capacity single and double-acting dashpots, using liquid compressibility, provide a wide range to meet unusual energy-absorption requirements.

The 66 standard models are rated from 10 to 8,860,000 in-lb from the smallest $1\frac{1}{8}$ in. long by $\frac{1}{2}$ in. dia to the largest 70 in. long by $8\frac{1}{2}$ in. dia, respectively. **—K-16**

Optical Polygon

In effect a 360-sided optical polygon, a new Milichex Model MOX-3600, provides users with a multipurpose tool for optically checking alignment and angular spacing in any multiple of full degrees. Developed by Michigan Tool Co. the Model MOX-3600 is a compact, high-precision indexing device with an optical mirror mounted on its rim.

It is accurate to within 0.000012 in. at a 20-in. dia.

When used with an autocollimator or similar optical sighting device, the optical polygon provides an accurate mirror surface which reflects the projected image of the sighting device's cross hairs. The amount of deviation between the reflected image and the graduated cross hairs in the sighting device gives a geometric check on misalignment, parallelism, angularity, and the like.

Featuring versatility of use, the instrument is claimed to be ideal for shops having a large variety of optical checking needs. It replaces any conventional multisided polygon divisible into 360 deg. The Model MOX-3600 can be used for inspection, manufacturing, or in the field. **—K-17**

Digital Draw Indicators

Dynapar Corp., electronic subsidiary of Louis Allis Co., announces the introduction of a complete line of digital draw indicators for precise draw or speed measurement on paper machines and other similar applications. Digital draw indicators count the number of rotations of each of two rolls and electronically compute the ratio of these two quantities by a simple digital method. This ratio is then digitally multiplied by a single constant to simultaneously adjust for the actual diameters of the two rolls. The answer, which is the exact draw in per cent, is displayed on an indicator panel in illuminated numerals.

Digital draw indicators are available in Type A and B designs. Type A units have a maximum capacity of 5 channels for measuring 5 draws or speeds. Type B units are large-capacity console designs capable of handling as many as 50 draws or speeds. Request Bulletin 203. **—K-18**

Capsular Motor Insulation

The introduction of "Capsular" insulation system for encapsulated random-wound a-c induction motors has recently been announced by The Louis Allis Co.

The new encapsulated motors offer added protection against moisture, chemicals, oils, and abrasive contaminants, providing longer life for open motors used in adverse environmental atmospheres.

The smoothly encapsulated, void-free, conventionally wound stators feature heat-resistant plastic-resin that completely seals end coils and fills spaces between wires in the stator slots with a moisture-proof, chemical-resistant, protective sheath. The encapsulating material has high dielectric strength and exceptional thermal endurance, permitting operation over wide extremes and sudden changes of temperature without cracking, crazing, or breaking of the bond between the plastic compound and stator laminations or windings. **—K-19**

Centrifugal Pumps

The Deming Co. is producing end-suction centrifugal pumps that are easily adaptable to different pumping applications and capacities. Power frames are designed to accept different liquid ends and motors to increase capacity as pumping requirements increase. Designed to accommodate interchangeable liquid ends of cast iron, all bronze, stainless steel, and alloys, these pumps are capable of capacity ranges up to 3000 gpm. An additional feature is the adjustable impeller. Normal impeller wear poses no problem since the design permits easy "on-line" adjustment for continuous optimum capacity. **—K-20**


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Centerwind Drive Systems

Designed as an automatic tension rewind, a new Centerwind drive has been introduced by U. S. Electrical Motors Inc., as part of its Varidyne a-c frequency-controlled range drive system. This Centerwind drive is especially suited to applications involving plastic, paper, or metal winding where the material requires accurate control of tension as it builds up the radius on the reel.

By means of the variable a-c frequency provided by the U. S. Varidyne power unit, the Centerwind is automatically synchronized with the line speed, thus co-ordinating linear winding speed and line speed of the range to insure even tracking and better quality rolls.

The Centerwind drive eliminates the need for touching the material with dancers or other mechanical tension-sensing devices. The operator may set the tension at any desired level, for constant or tapered tension winding. The drive keeps the tension within the strength limitations of the web, avoiding the possibility of tearing and assuring even tracking at all times. This system also minimizes the possibility of damage to the edges of the rolled material. **—K-21**

Bearing Grease

High/low temperature ball and roller-bearing grease filtered to 10 or 45 microns is now available from Bearing Inspection, Inc. Grease is supplied in $^1/_2$-oz syringes, with needles, as a standard package unit, and will meet or exceed most "Mil Spec" requirement. It is believed that the primary application of the product is in the regreasing of permanently sealed bearings. However, many greasing problems currently existing in miniature and other precision bearings also can be solved readily.

The syringe packaging virtually eliminates handling contamination. Since the filtering greatly reduces the abrasive qualities normally found in most "MilSpec" greases, considerable expense can be eliminated due to the resulting extended bearing life. **—K-22**

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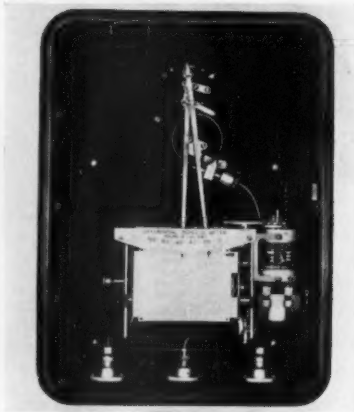

Strip Chart Recorder

A strip chart recorder that provides a record of flow, pressure, and temperature measurements for periods up to 36 days without attention has been introduced by American Meter Co. In announcing the new recorder, the company points out several advantages of this new product. The instrument is the cartridge type and makes possible reduced chart changing costs. Each cartridge, including chart, storage spool, and rewind spool is removed as a unit, so that chart changes can be made in a few seconds. No rethreading at the site is required. The cartridge will fit into the American chart integrator for fast chart interpretation.

With its chart capacity of 38 ft, the American strip chart recorder will provide an extremely legible record for a period up to 36 days on a single chart. Chart speeds are available from $^1/_3$ to 6 in. per hr, powered by either an electric drive or an American Gasclok power drive.

The American strip chart recorder can be used with instruments equipped with three pens for flow, pressure, and temperature, for use in orifice meters, pressure or temperature recorders, integrating orifice meters, or with telecounter transmitters or telemeter receivers. **—K-23**

Drafting Film Pencils

A new line of drawing pencils and leads for use on Mylar, Estar and Cronar polyester-base drafting films has been announced by Richard Best Pencil Co.

The Damascus polyfilm pencil is available in five degrees of hardness, and features Try-Rex, the exclusive Damascus pencil shape.

For those who prefer lead holders, Damascus polyfilm leads are also availabe in five degrees, identical to the polyfilm pencil.

A sample set of pencils and a folder on the new Damascus polyfilm line will be supplied on request. **—K-24**

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Mechanical Calculator

The Mathfaster calculator, developed by Pierce Mathfaster, simplifies difficult and frequently used mechanical calculations by condensing commonly used information into a simple, circular (7-in-dia) unit.

Eliminating the need for reference to wall charts, handbooks and data sheets, the Mathfaster permits rapid addition or subtraction of fractions and provides immediate access to such information as decimal equivalents of fractions; illustrated dimensions of round, flat, socket or fillister head screws and nuts; tap drills and threads per inch of NC and NF screws; decimal size of both letter and number drills; easily understood diagrammed formulas for solutions to triangles and areas or volume of basic forms such as circles, trapezoids, cones, etc.

Additional data provided include easy to compute gear and pulley calculations; gage number and thickness of standard sheet metal sizes; and frequently used slide-rule conversion factors. **—K-25**

Floating Locknuts

The Delron Co. a complete line of structural floating locknuts for honeycomb or sandwich-type panels. Many substantial advantages and savings can be obtained by these integral units over the use of standard floating nut plates. The Delron 700 series combines a floating nut element with a structural type panel fastener, which is fast becoming the standard of the industry. Simple installation procedures eliminate the need for intricate hole patterns and secondary riveting operations now required for conventional nut plates.

The Delron 700 series is available for $\frac{1}{4}$-in. panels and up, in sizes from 8-32 to $\frac{1}{4}$-28. Body section can be purchased in aluminum, carbon or stainless steel. **—K-26**

Small Metal-Cutting Machines

Racine Hydraulics & Machinery, Inc., is offering Models 66W2A (two speed) and 66W4A (four speed) in a line of stock feed small automatic metal-cutting machines.

These low-cost automatic saws combine hydraulics, electricity, and pneumatics in a simplified form for exceptional efficiency in tool room or production plant; they will cut all ferrous and nonferrous metals at speeds up to 140 five-in. strokes per min. Capacity is 6×6 in., actual $6\frac{5}{8}$ in. dia. The rugged length gage incorporates a fine micrometer screw adjustment that can be set quickly to hold lengths within 0.005 in. Minimum quantities of five or 10 pieces as well as much greater quantities can be cut automatically at operating savings because of the short setup time.

An accurately controlled hydraulic blade feed insures fast, straight cuts, and the work is held firmly by air chucks employing low air comsumption. **—K-27**

Midget Bearing

A self-aligning bearing, specially designed for small fractional-motor applications, has been introduced by Randall Graphite Bearings, Inc.

Available for shaft sizes of $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$, and $\frac{7}{16}$ in., this compact self-contained unit is a permanently lubricated bearing with a sintered-bronze bushing. The new design offers a substantial advantage over old-type sleeve bearings because it provides a bearing which is maintenance free; it eliminates the need for oil lines, reservoirs, oil cups, wicking, oil slingers, catchers, and so forth.

Installation is quick and easy with only minor change in the end-bell housing required to accommodate this bearing. These bearings are supplied to standard industry tolerances eliminating the necessity of an added sizing operation.

Tested over a 5-yr period, this new midget bearing gave top performance with no measurable depletion of the lubricant. **—K-28**

Four-Way Valve

A new $1\frac{1}{2}$-in. four-way valve, rated at operating pressures to 5000 psi, is being marketed by Denison Engineering Div., American Brake Shoe Co.

This new valve line, employing the same basic design features found in the company's existing $\frac{3}{4}$-in. valve line, can be operated by manual, mechanical, or electrical means. The valve is available as a thread, subplate or flange connected unit. Five different spools provide for open, closed or partially blocked flow-path connections at flows up to 90 gpm. **—K-29**

V-Belt Pulleys

An exclusive cam-control design to assure greater varispeed efficiency is an outstanding feature of a new series of wide V-belt pulleys rated at 1 to 5 hp at 1750 rpm. They provide variable ratios instantly up to 3 to 1. Known as Models 1060, 1160, 1280, 1390 and 1590, the pulleys are manufactured by Hi-Lo Mfg. Co., an affiliate of Lovejoy Flexible Coupling Co.

Each pulley face is independently actuated by its own spring and cam assemblies. The opposite wedging action of each cam and cam follower prevents pulley spread. This assures constant speed at all times, even under overload conditions. The cam action also automatically compensates for tension and alignment to keep the belt constantly in proper alignment and never under more tension than required by the load. **—K-30**

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Ground Thread Tap

A ground thread tap that will produce highest quality threads at 20 to 50 per cent faster speeds than conventional taps has been developed by Hanson-Whitney Co.

The new tap has true-tangent cutting edges and other major design improvements. These, together with the chip-removing advantages of steep-spiral flutes, make it possible to tap at much higher speeds with lower torque and greater accuracy. In ductile materials, these new Hi-Spi taps will produce uniformly accurate threads at extremely high rates of speed. This faster tapping results in improved productivity and lower cost. **—K-31**

Pressure Regulator

Micrometer accuracy is featured in the new series of pressure and flow regulators from Circle Seal Products Co. The Model R 4009 pressure regulator, suitable for supply pressures to 150 psi, maintains a precise outlet pressure with varying inlet pressure or flow. Pressure-balanced, low flow-force spool instantly corrects for changes. Regulated pressure accuracy is ± 0.25 per cent with varying inlet pressures. Full-flow porting and sensitive control actuation allow high flow rates in minimum size without pressure drop. Low-friction and low-flow force resistance insure accuracy with minimum hysteresis. Fingertip micrometer adjusts instantly; can be reset with a normal repeatability of ± 0.5 per cent. Model R 4003 flow regulator provides flow ranges from 5 to 300 scfh. **—K-32**

Plasma Spray Gun

A new 80-kw arc-plasma hand spray gun deposits coating material over three times faster than any other portable plasma spraying device, according to Plasmadyne Corp.

The gun's high deposition rate is expected to be a cost saving factor for job shop operations involving spray coatings of high melting point materials on interior or exterior surfaces. Zirconia, for example, a frequently used refractory oxide, is deposited with the new gun at a rate of 10 lb per hr. Corresponding rates for alumina and tungsten are 12 and 20 lb per hr, respectively.

The gun weighs only 4.5 lb and measures $2^3/_4$ in. in dia by 4 in. long. The gun is designed for use with standard Plasmadyne consoles as complements Plasmadyne's 25 and 40 kw spray guns.

Expected major applications include refractory coating of rocket nozzles and other hyperthermal-errosive objects, and commercial spray bonding of primer coatings with normally incompatible base materials. **—K-33**

Selector Valve

A newly designed dual-pressure, or two-stage Lo-torq selector valve is announced by Republic Mfg. Co., maker of valves and hydraulic components. It is noninterflow, smaller in size, and lighter in weight.

There is constant seal with the noninterflow design, so there is no fluid-flow between ports when the valve is turned. Neither is there loss of fluid from an accumulator pressure system. Another advantage of the design is that in the operation of a press it enables rapid operation for bumping. It supplies high volume at low pressure, and low volume at high pressure.

The new design is comparatively smaller, yet flow characteristics are about the same. Handle turning torque is lower; i.e., 105 deg handle turn, with 4 positions. This design is standard in $^1/_2$, $^3/_4$, 1, and $1^1/_2$ in. sizes, internal pipe thread, and is recommended for both water and hydraulic services. **—K-34**

Hydraulic Cylinders

A patented, high-speed, self-regulating, "floating" cushion for hydraulic cylinders is available throughout the complete line ($1^1/_2$ through 14-in. bores) of hydraulic cylinders manufactured by the Miller Fluid Power Div., Flick-Reedy Corp.

The new cushion permits much faster cycling than previously possible. In high-speed cycling, the floating-cushion plunger also acts as an extra large check valve that allows comparatively large volumes of fluid to enter the cylinder around the piston rod. This speeds up the start of cylinder stroke in coming out of the cushion and eliminates the ball-check assembly customarily used. The ball-check assembly is replaced with a second adjusting screw which, together with the regular cushion-adjusting screw, permits easy access for cushion adjustment with either of the two screws.

The cushion plunger has a thin-wall, floating sleeve which automatically adjusts itself to trapped pressure under varying deceleration conditions. Thus, even at very high speeds, shock and pounding are eliminated because, as trapped pressure rises, sleeve compression increases to provide greater plunger clearance.

For slow-speed cycling, the sleeve automatically readjusts to full diameter to keep clearances to an absolute minimum, thus assuring effective cushioning at slow speeds.

The new, high-speed cushion is available as an extra-cost feature on both Miller Job-Rated (500 to 2500-psi) and Power Packed (3000 to 5000-psi) hydraulic cylinders. **—K-35**

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Bellows Seal

A new rotating bellows seal that will accommodate temperatures from −350 to +800 F has been announced by Sealol, Inc. The heart of this new seal, known as the Sealol 605, is a welded, stainless-steel bellows attached to a drive collar at one end and a carbon retainer for the carbon seal ring at the other end.

The 605 seal is of extremely simple design and construction. The bellows core and its two welded fittings rotate as a single unit. The mating ring, against which the carbon ring runs is, of course, stationary. There are no loose parts, no critical fits, or sliding elements. Because of the 605's temperature range and automatic pressure balance features, many applications are found in cryogenic service, high-temperature water, petrochemicals and similar areas of use.

—K-36

Industrial Fans

Garden City Fan & Blower Co. has announced a line of forward-curved centrifugal fans for heavy-duty industrial service. The compact units are particularly well suited for systems having limited space or low noise-level requirements.

Designated the FF line, the forward curved fans are produced in two basic models for a variety of industrial ventilating and high-temperature applications: FF industrial fans for 300 F maximum operating temperatures; FF Thermal-Aire fans for handling hot air or gases to 2000 F. Exclusive FF Thermal-Aire plug units are designed for direct installation in furnaces, ovens, kilns and driers, without external ductwork.

—K-37

Mechanical Indicator

A mechanical indicator specifically designed to measure peak compression and combustion pressures in high-speed diesel engines accurately has been introduced by Kistler Instrument Corp.

Readings are displayed on a micrometer-type scale which is graduated from 0 to 2000 psi in increments of 2. Completely self-contained, the pocket-size gage consists of a differential piston and cylinder in which the measured pressure is opposed by a spring force which varies with the setting of the micrometer thimble. The piston travel, about $^1/_{64}$ in. is transmitted to a plunger projecting from the end of the micrometer thimble, where the plunger motion is detected by the user's finger.

—K-38

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Air Operators

A complete new line of air-powered diaphragm operators for remote actuation of its diaphragm valves is announced by Hills-McCanna Co. Three types of operators are offered: Air-open air-close; air-open spring-close, and air-close spring-open. Each is built in four sizes for $^1/_2$ and $^3/_4$ in., 1 and $1^1/_4$ in., $1^1/_2$ and 2-in. valves. (Other types of operators are available for valve sizes through 14 in.)

The spring-loaded operators return the valves to full-open or full-closed position in event of air-system failure. Where this is not necessary, the air-open air-close model offers the advantage of smaller size and minimum air-pressure requirement.

Hills-McCanna diaphragm valves with operators are available in a wide variety of materials, a few of which are carbon steel, bronze, ductile iron, stainless steel 303 and 316, as well as solid PVC, Saran, and Uscolite–and lined with glass, rubber, or plastic. Screwed, flanged, socket weld, and other end connections are available. Valve diaphragms can be furnished in a wide range of elastomeric and plastic materials, including Chlorobutyl and Teflon. Literature on air-operated valves available. **—K–39**

Swing-Check Valve

A full-flow, swing-check valve which is said to offer all the advantages of a check valve plus all the advantages of a flow control, for practically any liquid at any pressure or temperature, in one compact package is now available from Magnetrol, Inc.

Model FCV Magnetrol offers a valve disk magnetically coupled to the dependable Magnetrol switch mechanism, which features mercury-to-mercury switch contacts. Magnetrol's pneumatic pilot mechanism can be substituted for the standard electric switch mechanism as an optional feature of the new control. **—K–40**

Double Flow Regulator

A pressure compensated double flow regulator, developed by Fluid Controls, Inc., features twelve position detents, dustproof dial adjustments, and bottom-located ports for simplified installation.

The valve has four ports; an inlet, two 0 to 15-gpm regulated ports, and a by-pass port. Inlet and by-pass ports are $^3/_4$-in. pipe, and both regulated ports are $^1/_2$-in. pipe. The flow from the by-pass port can be independently utilized for system functions.

The valve incorporates two combination by-pass and restrictive-type flow regulators in series in a single body. The regulator can be installed readily in all types of fluid power systems handling pressures of up to 3000 psi. It permits manual adjustment of hydraulic fluid flow to two separate functions. Single versions of the flow regulator valve are also available. **—K–41**

Flat-Head Cap Screws

Screw and Bolt Corp. of America has expanded its line of fasteners for industry with introduction of flat-head cap screws in diameters of $^1/_4$ through $^3/_4$ in. in all cataloged lengths.

The flat-head cap screw is a precision product, having somewhat the same appearance as a countersunk bolt and a flat-head machine screw. All surfaces of the head, point and the slots are machined. Concentricity, uniformly bright finish, and close tolerances are results of this method of manufacture.

Mechanical properties of these screws are enhanced by cold heading and rolled threading, imparting increased resistance to fatigue failure. Greater design flexibility, especially when fastening thin sections to an assembly, is allowed by threading up to the screw head. **—K–42**

Heavy-Duty Casters

A heavy-duty—100 per cent hardened—series has been added to Fairbanks Co. patented line of Lockweld steel "casters without a king-pin."

The Lockweld construction eliminates the king-pin or king-bolt, the major cause of swivel-caster failures, and replaces the nonrigid king-pin assembly with a rigid, welded structure. This construction locks the ball-bearing raceways in perfect, permanent alignment for easier swiveling.

Catalog sheets providing complete specifications, including load ratings for the casters with the various types of wheels, for the Series 25-35 casters are available. **—K–43**

Relief-Valve Manifolds

Series 8500 safety relief-valve manifolds has been announced by Bastian-Blessing Co. Available with 2, 3, or 4 safety relief valves in threaded mounts, these manifolds are designed for continuous, uninterrupted service on pressurized storage tanks containing LP-gas, butadiene and other selected hydrocarbons.

Designed for direct connection to a flanged tank opening, RegO manifolds require no inlet piping or shut-off valves. Because of a unique handwheel operation, the necessity for dual relief-valve systems is eliminated.

RegO 8500 series manifolds are available with brass-ferrous or all ferrous construction for set pressures between 40 and 300 psig. Standard B, G, GC, and T settings are also available. **—K–44**

Aluminum Alloy

A new aluminum alloy specially formulated to resolve some of the major problems of aluminum pattern making has been developed by American Smelting and Refining Co. Known as PT aluminum pattern metal, the new alloy provides effective control during casting by minimizing variations in shrinkage and eliminating occasional unpredictable extremes of shrinkage such as are experienced with most other pattern metals from time to time.

Foundries which have participated in a test evaluation program on the new alloy report a substantial decrease in the number of rejects due to shrinkage defects and noticeably more consistant foundry performance. **—K–45**

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Double Pump Power Units

A new line of 1000 and 2000 psi Double Pump Power Units for general industrial service has been announced by Hannifin Co., Dept. 140. Div. of Parker-Hannifin Corp.

The Hannifin DCP power unit is offered in standard 30 and 60 gal reservoir sizes, with combined pump capacities to 33 gpm. All units incorporate an 1800 rpm motor.

By utilizing double pumps in conjunction with the "Hi-Lo" Unloading Valve Panel, horsepower requirements are claimed reduced, oil temperatures lowered, and maximum circuit efficiency realized. DCP power units can also be supplied with two individual relief valves instead of the "Hi-Lo" Panel, when two separately operated hydraulic systems are required. **—K–46**

Rubber-Base Sealers

Two new extruded rubber base sealers with a unique cross-sectional "double donut" design that permits positive sealing of uneven or tapered joints, and 90-deg bending without the need of cutting and fitting operations are now available from the Adhesives, Coatings and Sealers Div., Minnesota Mining and Mfg. Co.

The sealers, designated as EC-2121 (hollow) and EC-2131 (solid) are designed to seal between mating metal surfaces. The sealers act and perform as a rubbery gasket when pressed into a seam and tightened between the sealing surfaces. Because of thier unusual cross-sectional design, these sealers will readily conform and provide an excellent seal around corners without the need for splicing or special fitting. Both sealers have excellent moisture, salt spray and weathering resistance. **—K–47**

BUSINESS NOTES

New Foxboro Division

The Foxboro Co., Foxboro, Mass. has announced plans to acquire the assets of Waugh Engineering Co., Van Nuys, Calif., manufacturers of electromechanical and electronic instruments, in exchange for 12,806 shares of its common stock. The firm will be operated as a division of The Foxboro Co. and will continue under the direction of its founder, Charles C. Waugh. No changes in personnel are anticipated.

In announcing the signing of a purchase agreement, R. A. Bristol, Foxboro executive vice-president, emphasized that Waugh products, particularly its turbine flow meters, are an important addition to the extensive Foxboro line of measuring and controlling instruments for the process industries.

Flo-Tronics Merger

Flo-Tronics, Inc., Minneapolis, Minn., has announced the completion of a merger with Waters Corp., Rochester, Minn., manufacturer of medical electronic equipment. William P. Edmunds, president of Flo-Tronics stated that plans are under way to establish a West Coast division for the Waters Corp., expanding its medical electronic product line, and broadening the scope of the Flo-Tronics Electronics Control Div.

Flo-Tronics presently has two divisions and five subsidiaries in the electronics, medical, material handling, and molding fields.

LATEST CATALOGS

Weld Couplets

A four-page brochure by means of tables and diagrams outlines specifications for forged-steel weld couplets manufactured by Henry Vogt Machine Co.

Vogt weld couplets adapt to any pipe or vessel curvature by simply adjusting the height position of the couplet when welding. This characteristic means easy installation, positive positioning and alignment, a stronger weld without distortion, and no inside "icicles" of welding material. Couplets are available in carbon steel, conforming to ASTM specifications. **—K–48**

Heat Exchangers

Design details of shell-and-tube heat exchangers are discussed in Griscom-Russell Co. Bulletin No. 101. Illustrations and tables show design and fabrication of custom shell-and-tube exchangers for the petroleum, petrochemical, chemical, and allied industries. **—K–49**

Insulated Wire

Bulletin M.1 describes AerOpak type insulated wire of the Aero Research Instrument Co.

Ceramic-insulated, metal-sheathed wires are being used more today in markets such as atomic energy, aircraft and even general industry.

New advances in manufacturing have made it possible to produce longer lengths to closer electrical and physical tolerances than ever before. The problems of sheath splits damaged wires and insulation voids found in the old process of single swaging are alleviated.

Special assemblies, such as triaxial and bi-triaxial thermocouples are now possible and practical where before they were not. **—K–50**

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Surface-Rolled Patterns in Steel

The name "Sharonart" identifies steel with rolled-in, surface design patterns produced by Sharon Steel Corp. A designer's handbook gives complete information concerning Sharonart sizes, pattern designs and identification numbers, actual and suggested product uses, and methods of fabrication. Sharonart is said to offer many advantages to the designer which are not found in other metals; such as simplicity of product change, eye appeal, and mar resistance. —K-51

Flat-Top Chain

Bulletin No. 9 of the Acme Chain Corp. describes a new flat-top conveyer roller chain that is based on the long-felt need of the conveyer industry for a flat-top chain that will operate continuously, without breakage and a minimum of wear. The top plates are made of "Delrin" which has excellent room-temperature properties, resistance to foods, such as tea, catsup, vinegar, margerin, mustard, and also to industrial materials such as oils, greases, and other lubricants. The bulletin includes prices, sizes, and full description of flat-top roller chain. —K-52

Self-Aligning Locknut

A return to perpendicularity in nut-bolt fastening is urged by Standard Pressed Steel Co. in a technical bulletin recently published. It reviews a new self-aligning locknut, SPS SA 16, that compensates for out-of-squareness conditions as great as 8 deg.

Diagrams illustrate the action of the two-part nut in restoring perpendicularity (that is, eliminating destructive bending) of bolts in cases of surface misalignment.

The effect of bending on bolt fatigue life is described. According to the bulletin, as little as 2 deg of misalignment is enough to reduce by 90 per cent the fatigue life of a nut-and-bolt combination. With use of the new SPS SA 16 there is no loss of fatigue life up to 8 deg of misalignment. —K-53

Metallizing

Plant production men, who are increasingly concerned with maintenance cost reduction, will be interested in a six-page bulletin issued recently by METCO Inc., entitled "How to Save Money and Cut Downtime with Metallizing." The case history approach is used, with nine separate stories of cases where products were salvaged or improved with modern metallizing. Examples cover flame spraying with metals in both wire and powder form, and cite dollar savings. Unusual touch is METCO's suggestion that a plant does not need a metallizing installation if it takes more than a year to pay for itself. In that event, the company advises, use the services of a local job shop. METCO is the new corporate name for Metallizing Engineering Co. —K-54

Digital Computer

Autonetics Industrial Products in a four-page bulletin provides information on Recomp II, a general purpose computer.

Recomp II features for ease, versatility, and reliability of operation include: Large memory capacity, standardized teletype tape configuration, high-speed data input, all transistorized, control console with digital readout, built-in floating point arithmetic, physical advantages, and simplified programming and operation. —K-55

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Testing Equipment

A six-page brochure, SED 100, describing the unique services of its Special Equipment Div. and illustrating recently developed equipment has been issued by The Meriam Instrument Co.

The booklet contains eight illustrated types of equipment and outlines their function and capabilities. It also explains how the integrated facilities of Meriam's Instrument, Electronics, Special Equipment and Meriam-Weld Divs. enable development of unique systems for precision control, operation, monitoring, and testing of military and industrial equipment. **—K-56**

Sight Flow Indicator

A new Visi Flo sight flow indicator bulletin is now available from OPW-Jordan. The two-page bulletin illustrates the 11 styles available, materials of construction, sizes, pressure, and temperature ratings, dimensions, maximum capacities and minimum flow for actuation (where applicable). Visi Flos are used to indicate flow of coolant or any product that flows through pipelines. The indicator is widely used in industry as an inexpensive device (merely a window in a pipeline) to help protect costly machines and minimize line stoppage damage. It is available in plain, propeller or magnetic types with screwed or flanged ends, for vertical or horizontal applications. Most types are made in aluminum, bronze, or monel $^1/_4$-6 in. **—K-57**

Diaphragm Motor Valves

Reliance Type CBVA and Type P diaphragm motor valves are described in two bulletins issued by American Meter Co. Bulletin 133 provides complete data on Type CBVA Models 500, 700, 800, 700P, and 800P. Model 500 is generally used for on-off service; Models 700 and 800 for pressure-reducing service controlled by a 3-15 psi signal pressure from a controller. Models 700P and 800P are designed for applications where unusually fast response and accurate positioning are required, especially when the distance between motor valve and controller is great.

Type P diaphragm motor valves described in Bulletin 137 employ a single streamline valve which permits pressure reductions as high as 1000 psi with minimum danger of freezing. Type P is recommended for difficult installations in gas field, transmission, distribution, and industrial services. **—K-58**

Compressors

Medium-speed, heavy-duty, balanced-opposed compressors for gas gathering, gas lifting, repressing, and booster service are described in Bulletin 124 of White Diesel Engine Div. of White Motor Co.

Tables, illustrations, and diagrams are included for general information. **—K-59**

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Heavy-Duty Press

The largest Havir Press-Rite ever built, a 125-ton OBI model, is described in a catalog sheet available now from Havir Mfg. Co.

Featured as a press for heavy-duty, bulky jobs, the catalog describes the 125-ton model as a multipurpose press. Such features as large die area and extended shut height make it applicable to many jobs.

The press has normalized weldment with specifically designed reinforcements. This frame, coupled with box-type flanged ram, assures production accuracy and gives greater life to dies. Up to 50 per cent die savings can be expected by users of the new press from tests reported by the manufacturer. **—K-60**

Bearing Screws

Roton Products Div. of Anderson Co. describes its antifriction bearing screw in an illustrated catalog. The Roton antifriction bearing screw is a highly efficient mechanism for converting rotary force and motion to linear force and motion, and vice versa, in a wide variety of actuating and positioning applications.

There are two basic types of drive assemblies, the planetary drive for speed reduction, mechanical advantage, and freewheeling feature which dissipates the driving torque at end of travel; and the positive drive for accurate linear advancement. **—K-61**

Motor Guide

Century Electric Co., has issued its 1961 Motor Application Guide, Bulletin 010. This 16-page bulletin describes Century's broad line of single-phase, three-phase and d-c motors. Gearmotors and selective speed drives are also treated.

Two motor selection charts appear in the bulletin—matching motor characteristics to specific applications for single-phase and polyphase, and direct-current motors. Polyphase and single-phase motor characteristics are discussed, and rating and dimension tables are included. **—K-62**

Annealed Stainless Steel

A four-page brochure of Sharon Steel Corp. demonstrates the use of annealed stainless steel in marine, automotive, office equipment, architectural, and other applications.

Stainless steel's important advantages have created a growing number of uses for this versatile metal. It is strong, corrosion resistant and good looking. Sharon's bright annealing process makes stainless steel even more attractive. It provides a bright decorative strip with improved corrosion resistance because it eliminates the surface oxides that form during conventional annealing. **—K-63**

Ball Valves

A line of ball valves is described in an illustrated catalog issued by Crane Co.

Crane ball valves are of simple design and of rugged construction for smooth operation under difficult conditions. They are available in bronze, carbon steel, and Type 316 stainless steel, in $^1/_4$ to 2-in. sizes. **—K-64**

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Pumps and Accessories

John Bean Div. of Food Machinery and Chemical Corp. is distributing several data sheets describing its line of Triplex pumps, accessories, and hose fittings. —K–65

Plastic Finishes

The Glidden Co. announces Glid-Tile in a four-page brochure. True plastic finish with exceptional durability in use as concrete block, wood, metal, plaster, wallboard. —K–66

GT Drive Unit

Bulletin No. 604 of Synchro-Start Products describes GT style units which will mount directly on a standard 0.187 shaft SAE tachometer take-off. In addition, they provide two side take-offs, one of which rotates clockwise and the other, counter clockwise. Flexible cables can be attached to these take-offs for driving other accessories such as a tachometer and hourmeter. If only one take-off is needed, the protective cap included with the unit may be left on the one not in use.

The auxiliary take-off shaft is driven by precision right-angle helical gears at the same speed as the governor shaft. Ball and needle bearings are used throughout so that exceptionally long life may be expected from these units. —K–67

Speed Nuts

Bulletin No. 353-1-10M-61 issued by Tinnerman Products, Inc., describes the many and varied uses for Speed Nut brand fasteners in appliances, automotives, electrical and electronic applications, farm equipment, offices, and toys. —K–68

Compressor Units

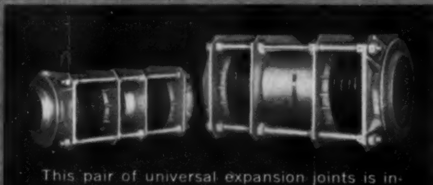
Catalog No. 790, published by Dunham-Bush, Inc., contains 28 individual pages with specification details for semihermetic, direct-drive, and belt-drive compressors and condensers ranging from 10 through 100 hp, designed for air-conditioning and refrigeration applications. The catalog includes mechanical specifications, product selection data, capacity ratings, rejection, loading and correction factors, dimensional data, and capacity control. —K–69

Optical Scanner

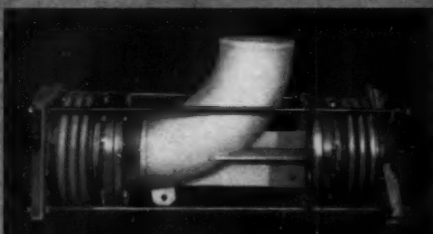
The Farrington Mfg. Co. describes its optical scanner in a brochure, "Optical Scanning What It Is and What It Does."

The optical scanner or "eye" reads, words and numbers, without the use of special inks or papers. Furthermore, the "eye" records what it reads. It translates data into "languages" that business machines can understand: punched cards, punched tape, magnetic tape. Optical scanning can work with all of these, from a simple punch-card system to the most sophisticated computer, and anything in between.

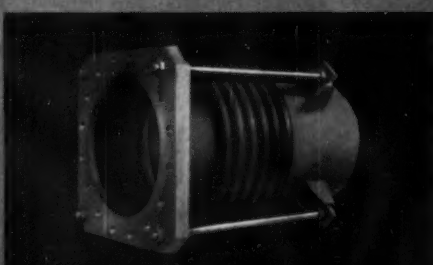
The Farrington optical scanner really "sees." Its video eye sweeps every character twenty-five times to pick out its identifying features. It recognizes digits, letters, and can even be programmed to identify a variety of symbols. And the "eye" works so quickly that it can read and punch up to 180 cards per minute. —K–70



This pair of universal expansion joints is installed in the vapor piping of a gaseous diffusion plant. The lines carry Freon 114 at pressures up to 500 psig and temperatures ranging from −20°F to 300°F. Joints accommodate 3" lateral movement under these extremely harsh service conditions.



A 12" pressure balanced elbow assembly specially engineered by Badger for use in LOX storage and transfer facilities at an Air Force Missile Base. The unit is designed to operate at temperatures from −297°F to 250°F — a thermal shock range of nearly 550°F. Operating pressures vary from 0 to 150 psig. Joint movement 0.8" axial, 0.15" lateral.



One of eight specially engineered Badger Expansion Joints at a power plant for a gas recovery unit in Texas. Installation is on a cooling water piping of the surface condensers where service conditions require operation at 55 psig at a temperature of 107°F. The joints are designed to absorb ½" lateral movement in combination with ⅛" axial movement.

This 24" x 44½" I.D. rectangular expansion joint, connects the turbine and condenser at a steam power plant. Each of the units is designed to operate at a pressure ranging from full vacuum to 1 psig at a temperature of 360°F. The joint handles ⅛" axial compression and a plus or minus ⅛" lateral movement.

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Anyone with the necessary manufacturing facilities can fabricate expansion joints. But it takes an *experienced* manufacturer to analyze tough piping problems properly and then provide the correct expansion joints to solve them. Badger, with more than 55 years in the field, has had more experience with a wider variety of special design problems than any other expansion joint manufacturer. Put this store of skill and knowledge to work for you — get the most effective and economical solution to your expansion joint problem. Call or write for complete information about Badger S-R Expansion Joints and our "on-the-spot" engineering service.

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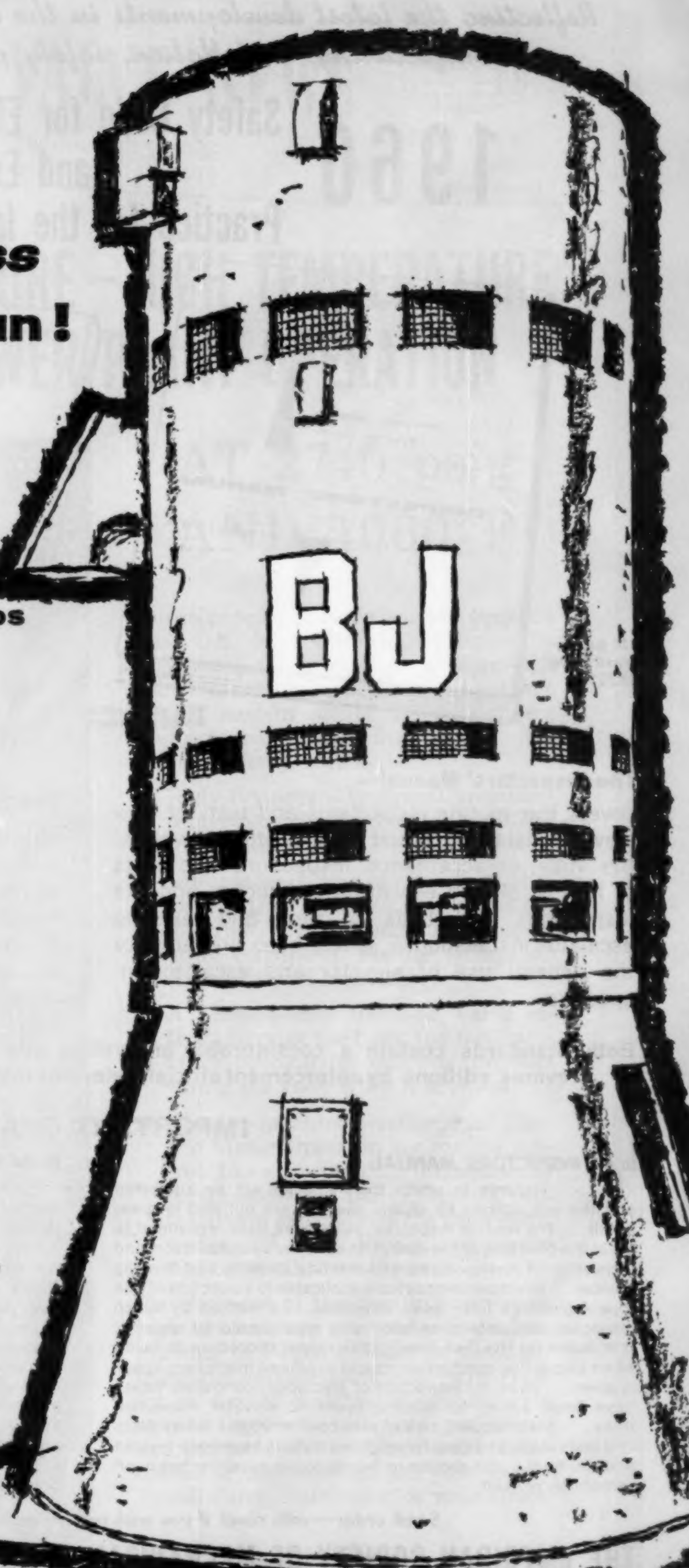


Quality *costs less* in the long run!

BJ Vertical Circulating Pumps

Designed to deliver water in large volume, BJ Vertical Circulating Pumps are in use on some of the Nation's largest industrial and governmental projects.

These BJ Quality Pumps are ideal for cooling tower circulation, irrigation service, flood control projects, municipal primary water pumping, river intake, dewatering for large construction, condenser circulation, industrial processing and other big jobs which demand the economy of long, reliable service.

Operating continuously with high efficiency, BJ Circulating Pumps are self-priming and require only a simple installation. Available in capacities to 50,000 GPM *in standard models,* and beyond on special order!

San Luis Water District

Located in California's San Joaquin Valley, the state's largest private agricultural improvement project has installed 10 BJ Vertical Circulating Pumps. Five at Station #1 total 4100 HP and deliver 69,600 GPM, while five more pumps at Station #2 handle 53,900 GPM using 2150 HP.

BYRON JACKSON PUMPS, INC.

Subsidiary of Borg-Warner Corporation

P.O. Box 2017-A, Terminal Annex, Los Angeles 54, California

BW

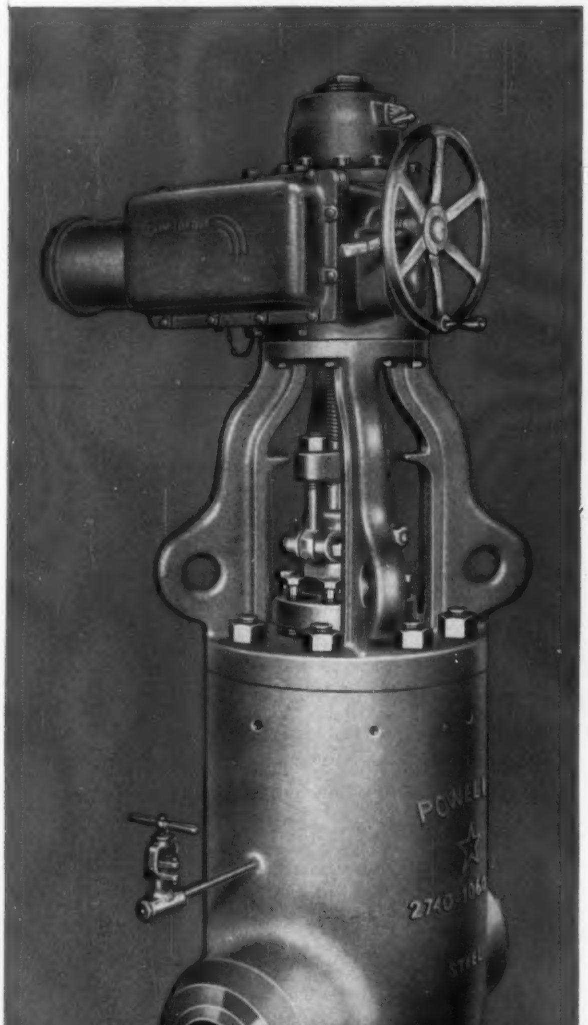
Circle No. 36 on Readers' Service Card

EXTRA POWELL VALVE NEWS

THE WM. POWELL COMPANY CINCINNATI 22, OHIO

115th year of manufacturing industrial valves for the free world

NEW HIGH PRESSURE—HIGH TEMPERATURE VALVE FOR POWER PLANT OPERATION



AT 2740 psig AND 1060° F

Powell proudly presents this new Pressure Seal O.S. & Y. Gate Valve, especially engineered for ultra high pressure-high temperature service in one of the nation's largest modern plants. Its outstanding performance results from many key design features, such as:

- Body, Bonnet and Wedge of Chromium-Molybdeum Steel, according to ASTM specification A-217, Grade WC9.
- Internal working parts constructed of long-wearing materials, proven for uninterrupted service under severe operating conditions. Stellite facings on the wedge and seat rings.
- A Chrome-moly Bleed-off Valve extends through the body and facilitates valve opening by relieving pressure within the valve when it is closed.
- The top mounted weatherproof Electric Motor Operator, for remote control, has a *Spring* that automatically compensates for the changes of contraction or expansion of the valve stem, wedge and body. Proper and precise seating at all times is assured.

Development of this new high pressure-high temperature gate valve is positive evidence of Powell's ability to meet any industrial valve requirement—with regular or special designs—in bronze, iron, steel or alloys—for water, oil, gas, steam, and corrosive service. For further information or assistance, consult your nearby Powell Valve Distributor, or write direct.

Circle No. 106 on Readers' Service Card

TORTURE-TEST PITS burst clutches to bits

Rockford Clutch reliability is due to the varied and frequent quality checks made at every production step. At specified intervals, clutches are removed from the production line and lowered into torture-test pits. Severe centrifugal tests spin these clutches to destruction! Each tested clutch, however, must withstand predetermined ultra-high speeds for specified time limits . . . another quality control check made to assure you of Rockford Clutch dependability. Rockford offers you an extremely wide range of proven power controls. Write today for illustrated brochure.

. . . assures you safe, enduring clutch performance!

ROCKFORD CLUTCH

1219 WINDSOR ROAD, ROCKFORD, ILLINOIS

Export Sales Borg-Warner International • 36 So. Wabash, Chicago, Ill.

DIVISION OF BORG-WARNER

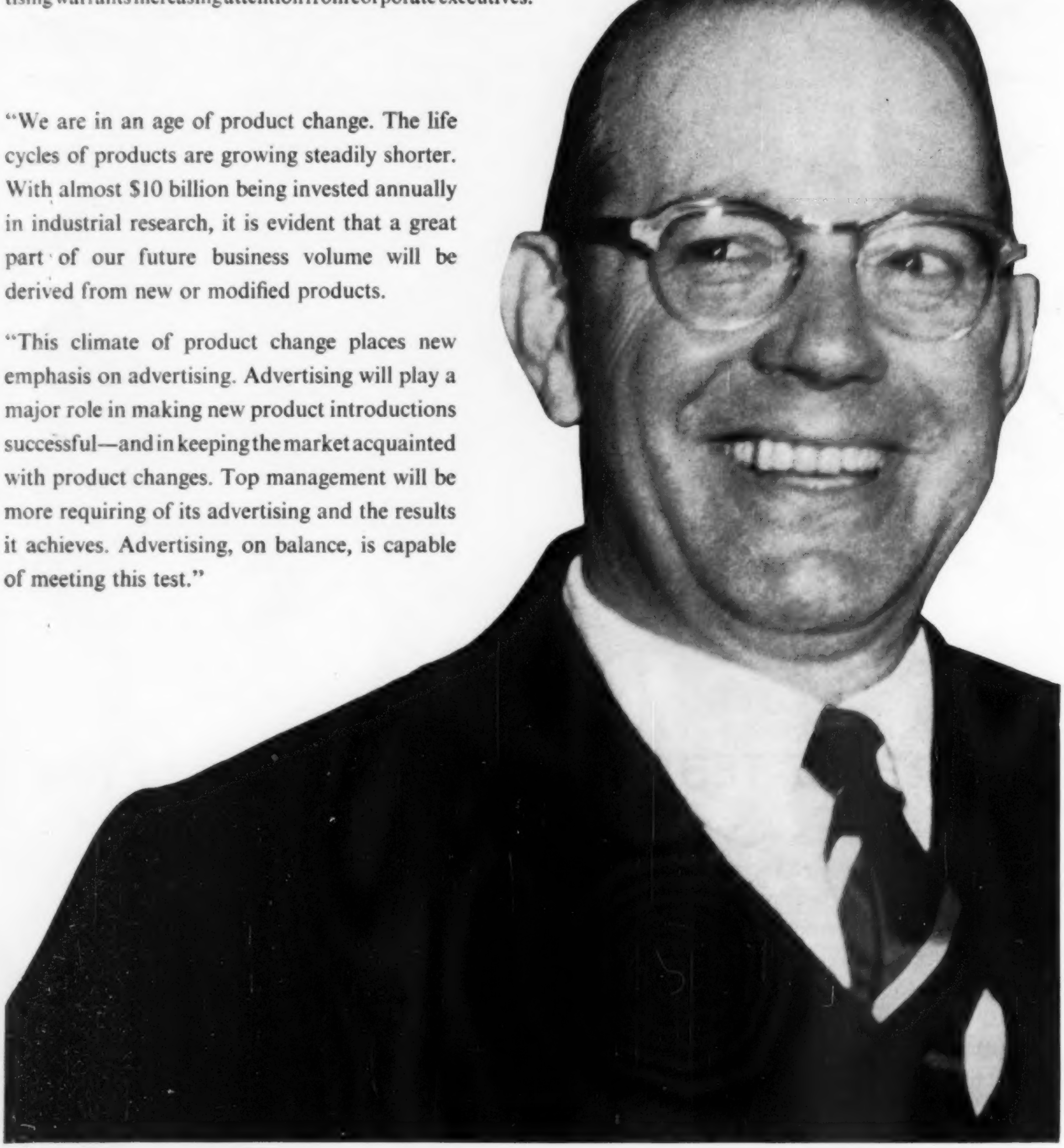
Circle No. 112 on Readers' Service Card

"More money for advertising! Why?"

James L. Allen, chairman of the management consultant partnership of Booz, Allen & Hamilton, explains why advertising warrants increasing attention from corporate executives.

"We are in an age of product change. The life cycles of products are growing steadily shorter. With almost $10 billion being invested annually in industrial research, it is evident that a great part of our future business volume will be derived from new or modified products.

"This climate of product change places new emphasis on advertising. Advertising will play a major role in making new product introductions successful—and in keeping the market acquainted with product changes. Top management will be more requiring of its advertising and the results it achieves. Advertising, on balance, is capable of meeting this test."

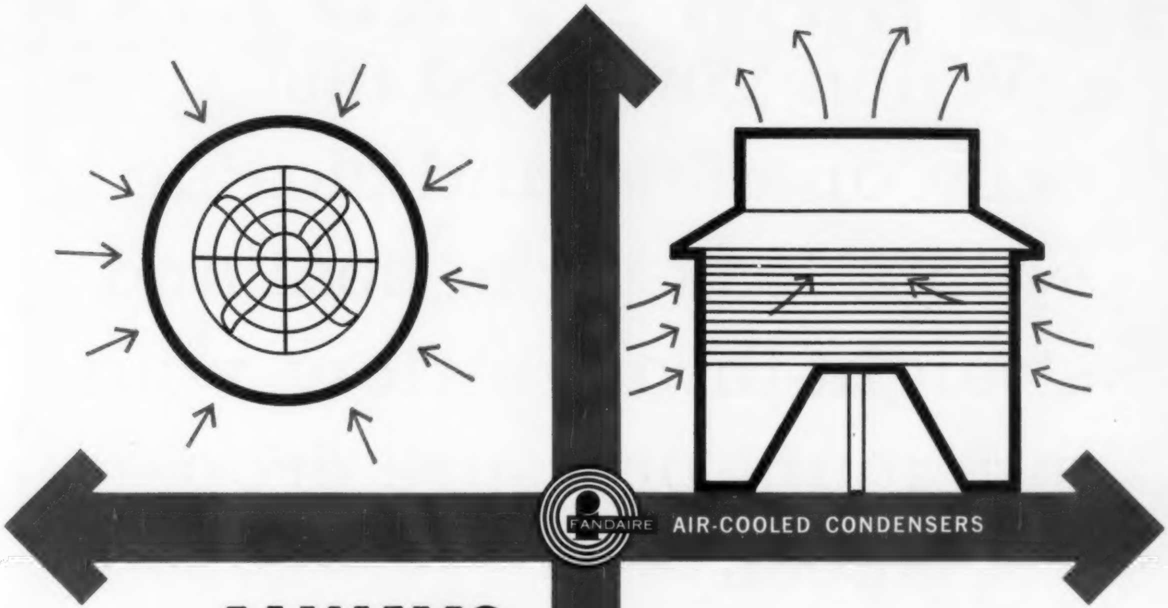


AIA

ASSOCIATION OF INDUSTRIAL ADVERTISERS

271 madison avenue • new york 16, n. y. • telephone murray hill 5-8921

An organization of over 4000 members engaged in the advertising and marketing of industrial products, with local chapters in Albany, Baltimore, Boston, Buffalo, Chicago, Cleveland, Columbus, Dallas, Denver, Detroit, Hamilton, Ont., Hartford, Houston, Indianapolis, Los Angeles, Milwaukee, Minneapolis, Montreal, Que., Newark, New York, Philadelphia, Phoenix, Pittsburgh, Portland, Rochester, St. Louis, San Francisco, Toronto, Ont., Tulsa, Youngstown.



ALWAYS FACED RIGHT

SET FANDAIRE ANYWHERE

REGARDLESS OF WIND DIRECTION

Fandaire's original circular design has basic exclusive features that are making this air-cooled condenser the new standard of the industry. There are good reasons why: this modern low silhouette condenser is engineered around the high heat-dissipating Yuba fintube. Every spiral is surrounded by swiftly moving cool air from every direction. Although Fandaire's heavier fin construction assures higher heat transfer efficiency, the entire unit weighs at least one-third less than ordinary condensers.

Fandaire's circular design eliminates return bends and allows a true counterflow arrangement – coolest gases meeting the coolest air. Cool air is drawn in from all sides, not off the hot roof . . . hot air is expelled up and out. The entire unit can be positioned where needed, without guy wires or extra bracing. Piping and installation savings can be considerable.

Built for industrial, commercial and home installation – from 3 to 120 tons, single or multiple units. Get full details today.

YUBA

specialists in circular air-cooled condensers and condensing units

YUBA FANDAIRE DIVISION
Tulsa, Oklahoma

YUBA CONSOLIDATED INDUSTRIES, INC.

Circle No. 145 on Readers' Service Card

When you need fast, easy opening and closing with a leak-proof seal and straight-through flow with minimum pressure drop specify

EVERLASTING

BOILER BLOW-OFF
Quick acting, also handwheel operated "Y" and angle types. For pressures up to 600 psi.

GENERAL SERVICE
Where drop-tight seal and full flow is essential.

CYLINDER OPERATED
Can be remotely controlled, electrically or manually.

STEAM JACKETED
Assures free flow of viscous materials.

WEIGHT-OPERATED
For automatic drains or emergency shut off.

WRITE FOR BULLETIN

EV-409

EVERLASTING VALVE COMPANY, 80 FISK STREET, JERSEY CITY 5, N.J.

Circle No. 51 on Readers' Service Card

EXCLUSIVE from K&E

the Complete Line on Polyester Film

and every film with "engineered" drafting surface

Only K&E offers you all the film-based media for your drafting and reproduction needs, and they're all *working* products, designed to permit additions or deletions. The same engineered drafting surface throughout enables you to standardize on drafting techniques, and the same base throughout means constant behavior characteristics under exposure to light, heat, moisture, etc.

1. HERCULENE® – the unchallenged leader among drafting films, with better than ever working properties for pencil, ink, and typing. Now with a choice of specialized writing mates: *Duralar* plastic pencils render tracings that are completely washable in soap and water ... new *Ruwe* pencils have all the fine "feel" of graphite, yet resist smudging better than graphite on regular paper.

2. PHOTACT® – the photographic second original *on film* that can be processed with regular *paper* developer. Image lines can be *manually* erased, too (no eradicators needed). Underneath – an excellent drafting surface for changes or additions in pencil, ink or typing. Available in three film types: Contact, Direct Positive, and Projection.

3. DUPRO® – for ink-like second originals that can serve as working copies. Image lines are smudge-proof, with appearance and permanence of photography, yet are easily removed with soft vinyl eraser. For additions or changes in pencil, ink or typing: a perfectly balanced drafting surface underneath. Another advantage: wash-off emulsion permits processing in room light – *no darkroom needed.*

4. HELIOS® – for intermediates of exceptional ruggedness, produced easily, quickly, and at *low cost* by the standard dry diazo process. Mechanical erasure removes image lines (no eradicators needed); engineered drafting surface on the reverse side. Unsurpassed line density and background clarity – black line or sepia.

5. STABILENE® – the *re-stabilized* drafting medium with unsurpassed dimensional stability. Ideal for highly precise work, like the preparation of multi-color maps, printed circuitry, lofting layouts, tools and templates, etc. Available with more than 20 types of surfaces – for pencil and ink work, scribing, peeling, stripping, and a variety of reproduction methods.

For more information on any of these popular K&E polyester-base films, simply mail the coupon below.

K+E

KEUFFEL & ESSER CO.

NEW YORK • HOBOKEN, N. J. • PHILADELPHIA • DETROIT
CHICAGO • MILWAUKEE • ST. LOUIS • DALLAS • DENVER
SAN FRANCISCO • LOS ANGELES • SEATTLE • MONTREAL

KEUFFEL & ESSER CO., Dept. ME-7, Hoboken, N. J.

Gentlemen:

Please send me your new brochure titled "Complete Line on Polyester Film."

Name & Title: ____________________

Company & Address: ____________________

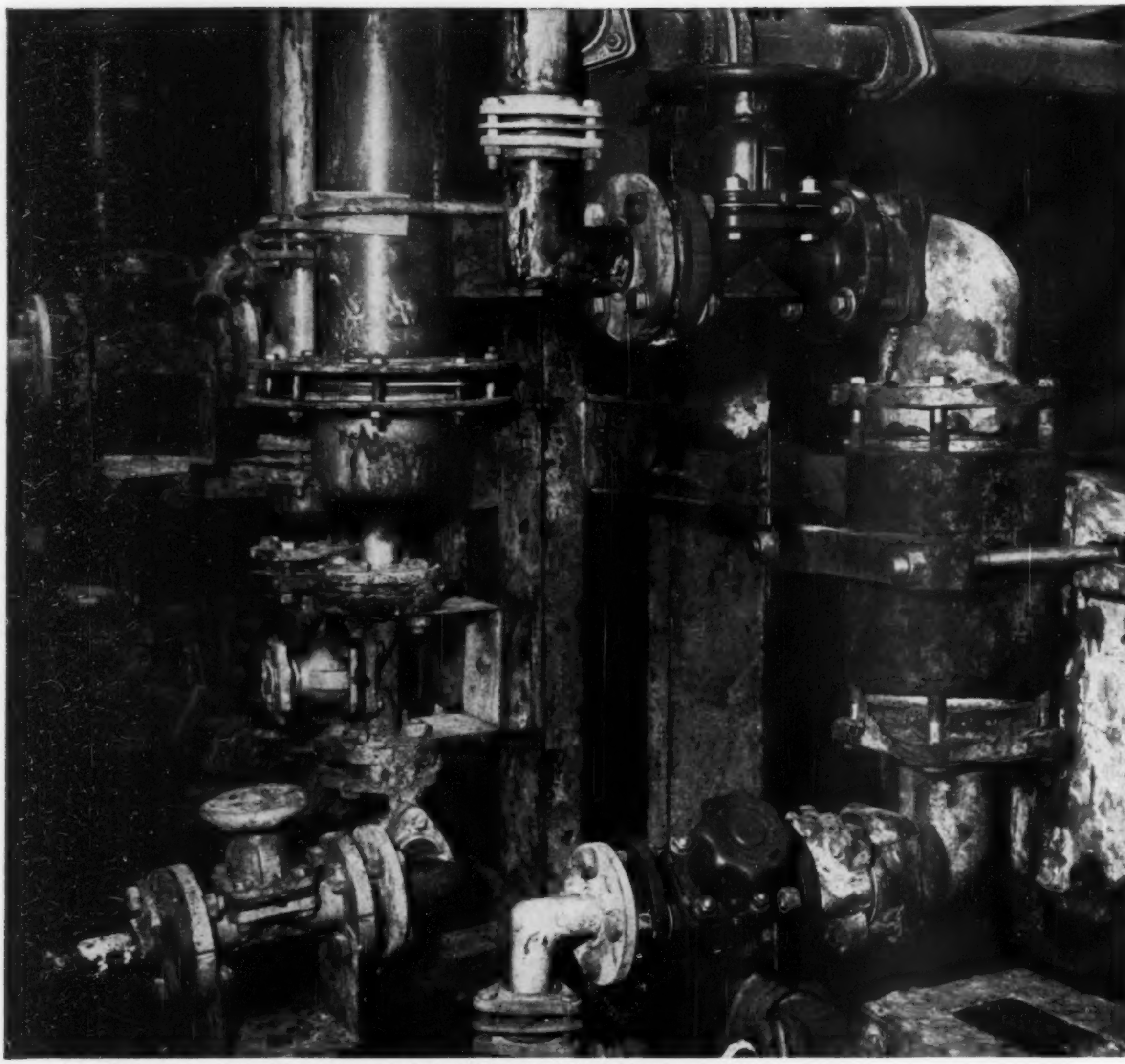
____

3093-A

Circle No. 79 on Readers' Service Card

MECHANICAL ENGINEERING

June, 1961 CARD INDEX Vol. 83, No. 6



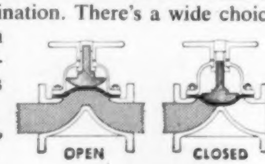
Encrustation on two of the above valves was cleaned off to show lack of external corrosion.
Compare this with the corroded condition of the structural steel.

Grinnell-Saunders Diaphragm Valves resist attack by hot corrosives at Carborundum Metals Company

During the past few years, Carborundum Metals Company, a Division of the Carborundum Company, has installed over 200 Grinnell-Saunders Diaphragm Valves at their Parkersburg plant in West Virginia. These valves were coated internally and externally with Penton* —and were equipped with fluorinated plastic diaphragms, backed with elastomer cushions. Their job: to handle highly corrosive caustic soda and sodium hypochlorite–at 212°F, and methyl isobutyl ketone, hydrochloric acid, sulphuric acid at 130°F–all used in processing zirconium ore for zirconium and its co-product, Hafnium.

Today, this manufacturer reports that after being in operation an average of two years, the rugged Grinnell-Saunders Diaphragm Valves are still giving good service. What's more, they've never had to replace parts in these Grinnell Valves!

In Grinnell-Saunders Valves, the diaphragm lifts high for streamline flow – seals *tight* for positive closure. Working mechanism is completely isolated from material in the line to prevent corrosion and contamination. There's a wide choice of body, lining and diaphragm materials, too. See how Grinnell-Saunders Diaphragm Valves can help *your* installation.



Write Grinnell Company, Providence 1, Rhode Island.

* *Reg. T.M., Hercules Powder Co.*

GRINNELL

GRINNELL COMPANY, PROVIDENCE 1, R. I. • BRANCH WAREHOUSES AND DISTRIBUTORS FROM COAST TO COAST
PIPE FITTINGS • VALVES • PIPE HANGERS • PREFABRICATED PIPING • UNIT HEATERS • PIPING SPECIALTIES

Circle No. 66 on Readers' Service Card

OPPORTUNITIES

positions open • positions wanted • equipment, material, patents, books, instruments, etc. wanted and for sale • representatives • sales agencies • business for sale • partnership • capital • manufacturing facilities

ANSWERS to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

RATES: Classified advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $4.50 a line. $2.00 a line to members of ASME. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display advertisements carried in single column units of multiples of one inch at flat rate of $45.00 per inch per insertion. Copy must reach us not later than the 10th of the month preceding date of publication.

MECHANICAL ENGINEER

Excellent opportunity in technical service on lubricating oils. Work involves design and operation of bench-scale equipment in evaluating lubricant properties. Chemical background or interest desirable. Experience in comparable activity preferred, but not required. Candidates should have at least a Bachelor's degree. Metropolitan New York.

Qualified applicants will receive consideration regardless of race, creed, color or national origin.

Please send resume to:

W. F. Hergrueter
Research Department

SOCONY MOBIL
OIL COMPANY, INC.

412 Greenpoint Avenue
Brooklyn 22, New York

THERMAL POWER STATIONS
PROJECT SUPERINTENDENTS
ASSIST. PROJECT SUPERINTENDENTS
Civil–Mechanical–Electrical
START AND TEST ENGINEERS
SHIFT OPERATORS
LOCATION FAR EAST
Qualified applicants submit resume to
THE KULJIAN CORPORATION
Construction Division—Dept. C
1200 N. Broad St.—Philadelphia 21, Pa.

DEVELOPMENT AND SALES ENGINEERS

VALVES and mechanisms for critical high-pressure, high-temperature services in the growing marine, petroleum, process and power fields—including nuclear power.

CONTACT R. A. Kampwirth, Edward Valves, Inc., subsidiary of Rockwell Manufacturing Company, 1200 W. 145 St., East Chicago, Indiana.

MECHANICAL ENGINEER

We are looking for a man with an M.E. degree plus at least 5 years experience in the layout and design analysis of mechanical components for heavy equipment.

Applicants should have sound knowledge of gearing, bearings, drive arrangements, manufacturing tolerances and material specifications.

Please forward complete resume including salary requirement to C. R. Farrell.

DORR-OLIVER, INC.
HAVEMEYER LANE STAMFORD, CONN.

San Francisco

Refinery and Chemical Division offers immediate employment opportunities for mechanical, chemical or instrumentation engineers capable of assuming responsibility on design of major petrochemical, refinery or similar processing units.

Relocation allowances cover moving costs plus transportation reimbursement for you and members of your family. If you have an interest in a San Francisco assignment, please send a resume of experience, including your present and required salary, to George I. Copeland, Manager of Personnel.

Bechtel
Corporation
220 Montgomery Street
SAN FRANCISCO

MECHANICAL ENGINEERS

Research & Development Large Diesel and Gas Engines

COMPRESSOR & ENGINE DIVISION

WORTHINGTON CORPORATION

. . . Perform aerodynamic and thermodynamic analyses of two and four cycle turbocharged Diesel and Gas Engines.

. . . Conceive and conduct developmental programs.

. . . Recent graduates and experienced engineers will find a challenging and permanent career.

. . . Latest modern facilities including computers, good benefits, tuition refund program, excellent local schooling, attractive salaries, liberal retirement plan.

To Apply: Send resume to:

James E. Gridley
Assistant Employment Manager
Compressor & Engine Division
WORTHINGTON CORPORATION
P. O. Box 953
Buffalo 5, New York

SUPERVISOR

Automation and Mechanization

ARMOUR RESEARCH FOUNDATION offers an exceptional opportunity for a highly qualified engineer as Supervisor of our Automation and Mechanization Section. This position entails the direct technical and administrative leadership of a group engaged in research in the areas of:

- **Remote-Controlled Mechanisms and Programmed Machinery**
- **Servo mechanism Applications**
- **Automatic Machinery Systems**
- **Pneumatic and Hydraulic Devices**
- **Kinematic and Mechanism Analysis and Design**

Candidates for this position should possess an M.S. to Ph.D. in Mechanics or Mechanical Engineering and experience in Mechanism Design Activities and Administrative experience in research and development.

ARMOUR RESEARCH FOUNDATION is a well-known independent research organization with a staff of over 600 engineers and scientists, which conducts a wide variety of research programs for industry and government. In this position you will have an opportunity to develop research areas of great appeal to you and your staff. Our environment is midway between academic and industrial.

We are located in a large city offering many cultural advantages. We also offer excellent employee benefits including four weeks' vacation each year. Replies will be held in strict confidence. Please send complete resume and salary requirements to E. B. Beck.

ARF

ARMOUR RESEARCH FOUNDATION

OF ILLINOIS INSTITUTE OF TECHNOLOGY
10 W. 35th ST. • CHICAGO 16, ILLINOIS

SUPERVISOR

Structural Mechanics

ARMOUR RESEARCH FOUNDATION offers an exceptional opportunity for a highly qualified engineer or scientist as Supervisor of our Structural Mechanics Section. The position entails direct technical and administrative leadership of a group engaged in research in the areas of:

- **Static and dynamic analysis of structures**
- **Site hardening and protective construction**
- **New conceptions in Space Structures**
- **Nuclear Reactor Vessels and Structures**

Candidates for this position should possess a Ph.D. in Mechanics, Mathematics or Mechanical Engineering, a proven record of professional achievement in research and development as evidenced by publications, and experience in administration of a research activity.

ARMOUR RESEARCH FOUNDATION is a well-known independent research organization with a staff of over 600 engineers and scientists, which conducts a wide variety of research programs for industry and government. In this position you will have an opportunity to develop research areas of great appeal to you and your staff. Our environment is midway between academic and industrial.

We are located in a large city offering many cultural advantages. We also offer excellent employee benefits including four weeks' vacation per year. Replies will be held in strict confidence. Please send complete resume and salary requirements to E. B. Beck.

ARF

ARMOUR RESEARCH FOUNDATION

OF ILLINOIS INSTITUTE OF TECHNOLOGY
10 W. 35th ST. • CHICAGO 16, ILLINOIS

ENGINEERS

Centrifugal Water Pumps
Ejectors and Other Jet Products

Expansion of our line requires experienced graduate engineers, preferably ME, for each of the above products. Must be able to handle all phases of design and development leading to introduction of new products. Not associated with government contracts. Relocate in Northwestern Illinois. Send detailed resume including salary requirements to:

Address CA-7177 care of "Mechanical Engineering"

NATIONAL BUREAU OF STANDARDS

U. S. Department of Commerce

Fire Research

Mechanical Engineer or Physicist with MS or PhD for fundamental and applied research on problems related to unwanted fires. Applicant must have demonstrated technical ability in two or more of the following fields; combustion, heat transfer, fluid mechanics, and instrumentation. This is an outstanding opportunity for a man to assume a leading role in development of a large research program. Unusual opportunity for publication of research findings at an organization offering desirable attributes similar to those of an academic research laboratory.

Career Civil Service. Salary to $10,635.00 a year depending on qualifications.

Apply to:

Dr. A. F. Robertson
National Bureau of Standards
Washington 25, D. C.

POSITIONS OPEN

MECHANICAL ENGINEER. Excellent opportunity at Project Engineer level for BSME with minimum 10 years' experience, preferably in heating, ventilating, and air conditioning. Position permanent and open immediately with established Midwest consulting firm designing industrial plants, power houses, public buildings, office buildings, laboratories. Moving expenses paid. Address CA-7130, care of "Mechanical Engineering."

MECHANICAL SPECIFICATIONS WRITER. Capable man with broad experience in specification writing for mechanical phase of building construction work is sought immediately by large Midwest consulting firm. Moving expenses paid. Resume showing educational background, experience, personal qualifications should be sent. Address CA-7145, care of "Mechanical Engineering."

MECHANICAL ENGINEERING teaching position. Man with Ph.D. (preferred) on Master's degree with course work for Ph.D. in the thermodynamics—heat transfer field to teach at the undergraduate and graduate levels. Address CA-7148, care of "Mechanical Engineering.

MECHANICAL ENGINEERS, experienced in design of large turbine generator installations, power system analysis and project engineering for Southern location with established expanding consulting firm. Also opportunity for experienced air conditioning designer. Please send complete resume of past experience including job references and salaries received. All replies will be held confidential. Address CA-7175, care of "Mechanical Engineering."

ENGINEER or ENGINEERING-PHYSICIST with training and experience in direct energy conversion to teach and direct graduate research at midwest state university. Ph.D. essential. Salary and rank commensurate with qualifications. Address CA-7187, care of "Mechanical Engineering."

PROFESSOR OF INDUSTRIAL ENGINEERING—Ph.D. degree. Teaching and Industrial Experience required. Operations Research specialization preferred. Salary appropriate to qualification. Department of Industrial Engineering, Syracuse University. Syracuse 10, New York.

MECHANICAL ENGINEER—Experienced on materials handling equipment, drives, and controls. Salary commensurate with length of experience. Address CA-7185, care of "Mechanical Engineering."

POSITIONS WANTED

SALES ENGINEER—ME with complete background in heavy steel manufactured products, including thorough familiarity with design, manufacturing procedures and erection of fabricated piping, heat exchangers and pressure vessels, and sales to top consulting engineers, public utilities, oil refineries, chemical plants, etc. Desires growth opportunity metropolitan New York area. Address CA-7163, care of "Mechanical Engineering."

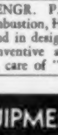
MECHANICAL ENGR. P.E. 45; For Project-Development in Heat transfer, Combustion, Hydraulics, Control systems, Heatg. & Vent. Background in design and application; heavy in power plant. Proven inventive ability. Will send detailed resume. Address CA-7176, care of "Mechanical Engineering.

EQUIPMENT FOR SALE

$LX^3 + MX^2 + NX + 1 = 0$—Don't waste precious time solving CUBICS? Reduce cubics quickly to $(AX2 + BX + 1)(CX + 1)$ with the easy to use CUBIC SOLVER slide chart. Send $2.98—F. W. Jackson, 318 Maple Ave., Drexel Hill, Pa.

EMPLOYMENT AGENCIES AND SERVICE BUREAUS

ATOMIC PERSONNEL, INC.



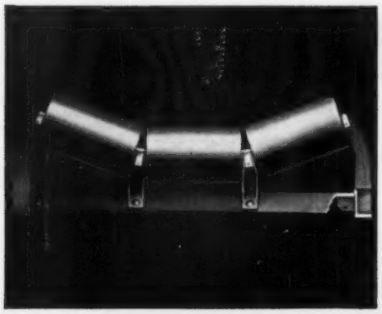
WRITE FOR APPLICATION OR SEND RESUME
•
CONFIDENTIAL HANDLING

A NATIONAL EMPLOYMENT AGENCY for the NUCLEAR FIELD
•
NO CHARGE TO INDIVIDUALS

Suite 1207-P, 1518 Walnut St., Phila. 2, Pa.

SALARIED PERSONNEL, $6,000 to $35,000. This nation-wide service successful since 1927 finds openings in your field. Sells your abilities: arranges contacts. Present position protected. Write for details—Jira Thayer Jennings, P. O. Box 674, Manchester, Vermont.

SALARIED POSITIONS—$6,000 to $35,000. We offer the original personal employment service (established 50 years). Procecure of high standards individualized to your personal requirements. Identity covered. Particulars—R. W. Bixby, Inc., 662 Brisbane Bldg., Buffalo 3, N. Y.



Jeffrey Permaseal® Idlers selected for Ko-Cal Roughloader

Koehring Company of California builds this Ko-Cal Roughloader to quickly and efficiently handle the largest loading jobs. It's being used extensively for low-bank borrow pits, highway cuts, mine stripping, and in use by top-soil dealers. Top capacity of the Roughloader is 1 yard per second. It moves sticky or rocky materials that tend to bridge and so cannot be efficiently handled by a feeder-type loader.

The practically maintenance-free service of these portable units depends in large part on the ability of Jeffrey Permaseal Idlers to help carry the load. Permaseal Idlers' unique double-seal design proves ideal for installations like this—where dust and dirt could create a real problem. On job after job, Permaseal Idler design protects bearings as they've never been protected before—stretches greasing intervals to years.

Complete information about how you slash direct and indirect costs with Jeffrey Permaseal Idlers is available in Catalog 925A. For your copy, write The Jeffrey Manufacturing Company, 915 North Fourth Street, Columbus 16, Ohio.

JEFFREY

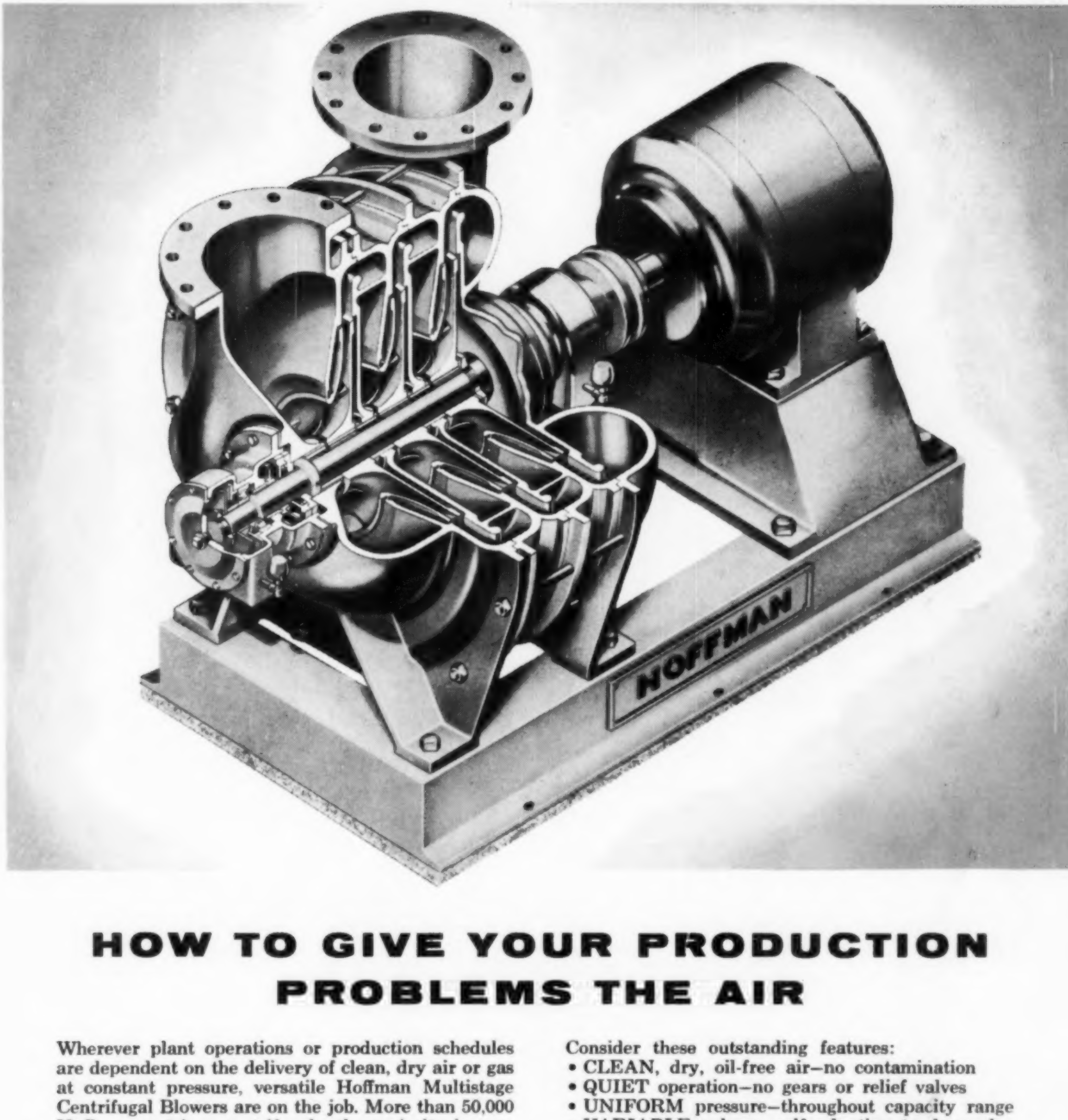
If it's conveyed, processed or mined, it's a job for Jeffrey.

INDEX TO ADVERTISERS

Advertisers appearing in previous 1961 issues

* The asterisk indicates that firm has product catalog in the 1961 Mechanical Catalog.

Your attention is directed to



HOW TO GIVE YOUR PRODUCTION PROBLEMS THE AIR

Wherever plant operations or production schedules are dependent on the delivery of clean, dry air or gas at constant pressure, versatile Hoffman Multistage Centrifugal Blowers are on the job. More than 50,000 Hoffman cast iron centrifugals—the majority in continuous 24 hour service—are currently at work reducing costs and *maximating* production in a variety of applications including combustion, agitation, gas boosting, drying, fluidizing, blow-off, aeration, flotation, pneumatic conveying and vacuum cleaning.

Hoffman Blowers and Exhausters provide pressures up to 10 pounds per square inch—vacuums to 12 inches of mercury—volumes out to 20,000 cfm.

Consider these outstanding features:

- CLEAN, dry, oil-free air—no contamination
- QUIET operation—no gears or relief valves
- UNIFORM pressure—throughout capacity range
- VARIABLE volume—self adapting to demand
- SMOOTH delivery—no pulsation, no snubbers
- OUTBOARD bearings—cast iron housings
- ONE-PIECE impellers—cast aluminum
- VIBRATION-FREE—dynamically balanced rotors
- LOW maintenance cost—no internal wearing parts
- PERFORMANCE—conforms to ASME test code

To learn how Hoffman air handling equipment can help solve your production and maintenance problems, call or write for illustrated catalogues.

Tax incentives for plant modernization benefit everybody

AIR APPLIANCE DIVISION

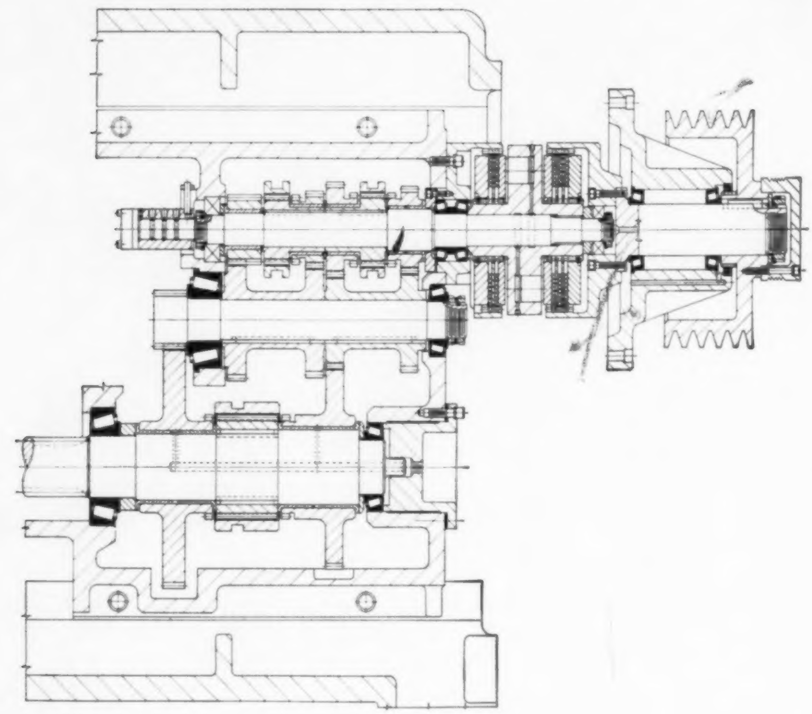
HOFFMAN

INDUSTRIES, INC. A SUBSIDIARY OF HOFFMAN INTERNATIONAL

Dept. ME-1 103 Fourth Avenue, New York 3, N.Y. ORegon 7-3600

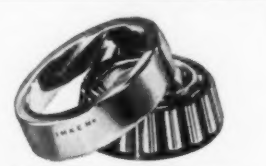
Circle No. 169 on Readers' Service Card

Bullard fully powered vertical turret lathe uses Timken® bearings to maximize production



When designing their Dynatrol® Vertical Turret Lathe, Bullard engineers' aim was to increase machine speed and output economically. Dynatrol provides single lever or remote control of all head motions, traverse and feed engagement. And Timken® tapered roller bearings at vital points—table radial position, head-stock, clutch shaft, input pulley, rail raising bracket—provide the load-carrying capacity under varying loads and speeds that assures maximum production. Their taper lets Timken bearings take *any* combination of radial and thrust loads. And precision manufacture of Timken bearings assures high precision in the machine.

ENGINEERING SERVICE THAT SAVES YOU TIME AND MONEY. Working with you at the design stage, our sales engineers can often solve your bearing problems on the spot. From the wide range of Timken bearing sizes, types and precisions they can help you select the Timken bearings to give you the maximum in efficient, economical design engineering.



Industry rolls on

TIMKEN®

tapered roller bearings

The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits. Canadian Division: Canadian Timken, St. Thomas, Ontario.

Circle No. 126 on Readers' Service Card